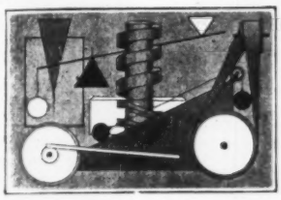
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 November, 1932 Number 11



Forthcoming ISSUES

MUCH will be said and done in the near future in the matter of styling machines. The alert engineer is beginning to appreciate (many have already) that sound mechanical design alone will not create a market.

Fortunately mechanical engineers have at their disposal the services of a group of qualified artist design consultants who specialize in styling, appearance and finish. One of these, outstanding in his field, is the author of an informative article to appear shortly.

L. E. Jermy

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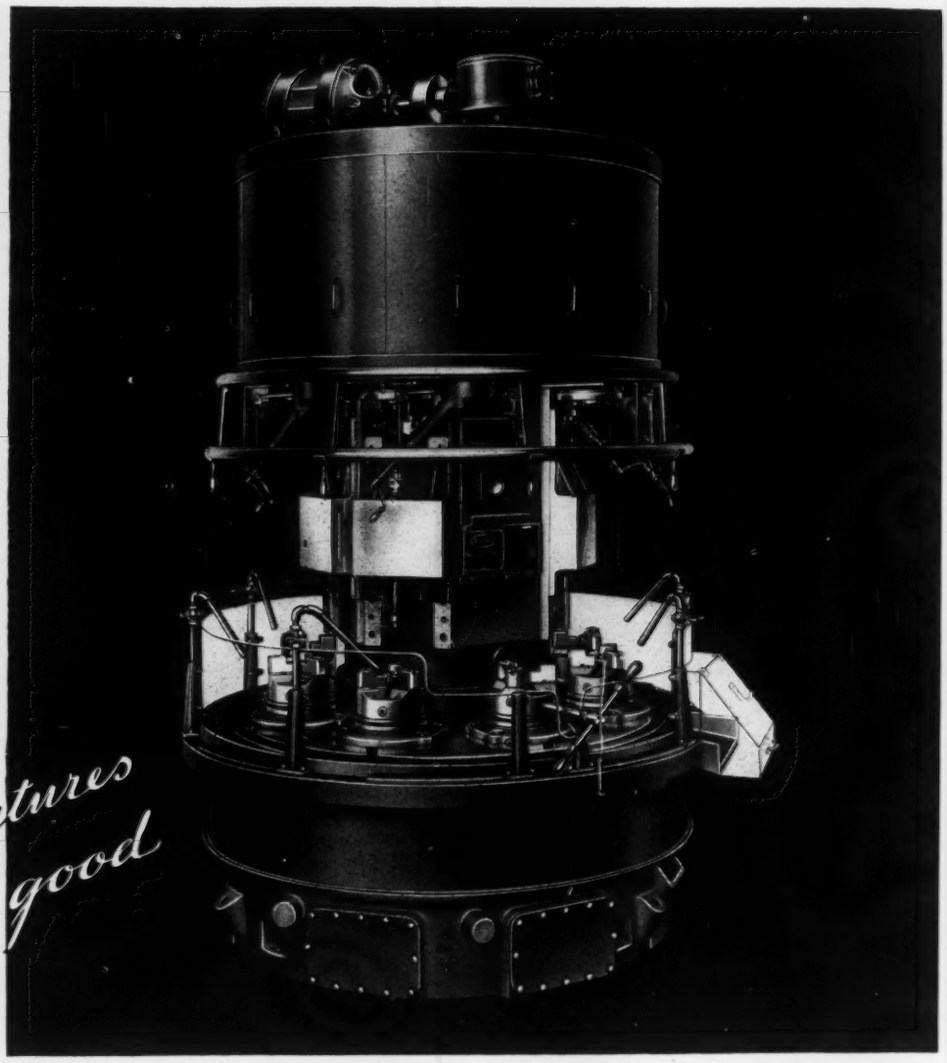

New Departures had to be good

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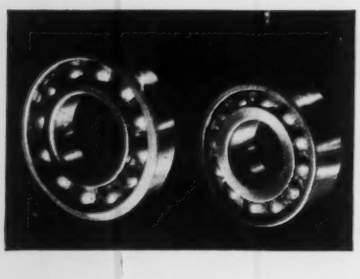
engineers and to maintain the high Mult-Au-Matic standards of accuracy, efficiency, and ability to stand-up under the severe stress of modern machining requirements. ✣ ✣ ✣ In Type "D" 8-Spindle Mult-Au-Matic, 98 New Departure Ball Bearings eliminate wear, increase years of useful life with economy of upkeep, assure an efficient ratio between input and delivered power with attendant savings, and provide smooth operation at the point of cutting. ✣ ✣ ✣ Nothing contributes more to the character and performance of a machine than good bearing engineering. New Departure engineers worked hand in hand with Bullard's in achieving this high efficiency. Every machine builder is invited to make use of this important branch of New Departure service. . . .



NEW DEPARTURE BALL BEARINGS

The New Departure Mfg. Company, Bristol, Conn.

Itemized Index, November, 1932

Key: Edit. Editorial Pages; Adv. Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

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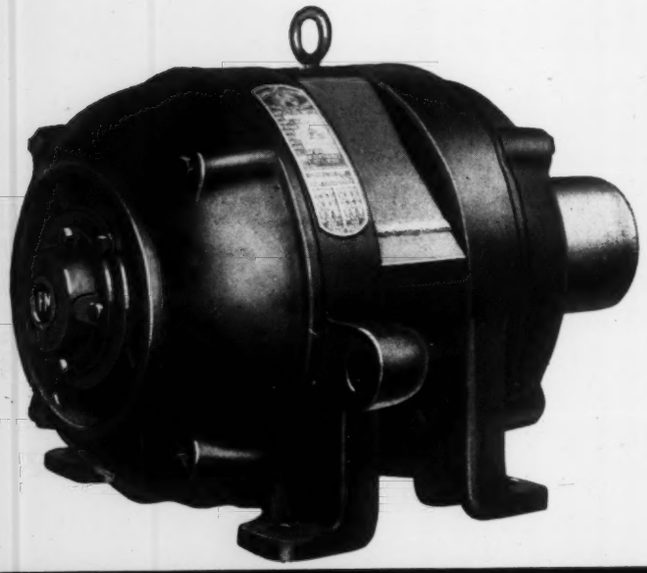
THROUGH the steady advance of civilization, man constantly is gaining new knowledge with which to improve his position. In industry his facilities for creating and developing new means of performing work are expanding rapidly. Almost daily new methods and new materials are made available for his use.

In this machine age, it is becoming increasingly necessary that those who are responsible for designing mechanical equipment be informed of the progress in machine design in all industries. More and more it is important that the ideas developed for one type of machinery be carefully scrutinized for possible application to other types. Today, to a greater extent than ever before, design is universal.



Explanations are bad in this market!

WHEN plants and machinery were working at full capacity, motor failures were serious enough. But with plant operation at partial capacity, when a plant has to produce merchandise quickly and is *halted* by a machine with a faulty motor—then, explanations are bad.

And it can't be explained easily. Always in your customer's mind the motor, whatever the make, is part of your machine—and he holds you responsible.

In these times of *extra* values, Fairbanks-Morse is putting additional worth into its motors. Construction features which enable you in turn to offer greater values to your sales prospects. Features which give added dependability and avoid the necessity of explanation for failure.

A *few* of these features are shown in the column at the right. The complete story of extra value in Fairbanks-Morse Motors will be sent on request. Fairbanks, Morse & Co., 900 South Wabash Ave., Chicago. 32 branches at your service throughout the United States.

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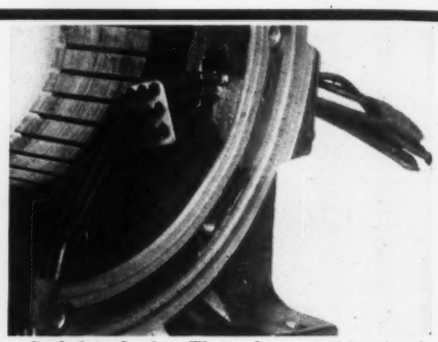
Use Flex-Mor for troublesome short-center drives. Replace long-center drives and conserve space while reducing transmission losses. Flex-Mor is durable; the silent, elastic drive reduces bearing pressures and requires no dressing or lubricant; unaffected by dust, dirt, moisture or atmospheric conditions.



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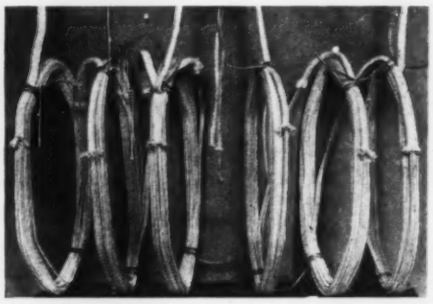
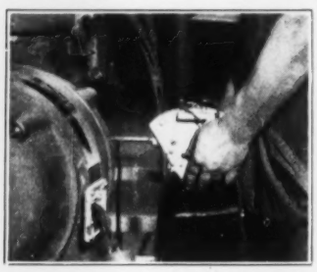


3. Group wound coils. A phase group winding from one piece of wire—reduces end connections and eliminates a source of mechanical failure. Lead connections from these phase windings are *welded*, not soldered or brazed. An innovation in winding construction that keeps motors out of the repair shop.



4. Every motor is given a thorough vibrometer test to make sure of proper running balance. Eliminate vibration and you reduce to a minimum the wear on bearings. Sealed-ball bearings and smooth running insure trouble-free service from F-M Motors under severest operating conditions.

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MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
November, 1932 Vol. 4—No. 11

Ingenuity Essential in Combating Temperature, Pressure

By Robert R. Harkins

HIGH temperatures and pressures inherent in certain types of equipment confront the designer in the selection of metals and packings and method of lubrication. Problems of this nature apply especially to the development of centrifugal and reciprocating hot oil pumps. Choice of proper metals not only involves the strength of the material at the temperature and pressure at which it is used, but difficulties arise also from unequal expansions and contractions encountered when the pump changes from room temperature to operating temperature and back. Erosion and corrosion caused by the fluid handled are other factors to be combated.

Similar problems are encountered by designers of steam turbines, internal combustion engines, ore smelting apparatus, fans, glass forming machines and other types of machinery in which temperature, corrosion and erosion must be considered.

When possible, alloys should be employed for this class of equipment with coefficients of expansion and thermal conductivity equal to low carbon steel. If alloys having a conductivity in excess of that for steel at operating temperatures could be secured, this would be most desirable. In general, however, alloys have lower conductivities than the pure metals. This is particularly true of the present high temperature, corrosion-resistant materials.

Thermal coefficient of expansion is of importance inasmuch as it determines to a large extent the types of materials which can be used together. In a hot oil pump it is desirable to make the wearing parts such as impellers, sleeves, etc.,

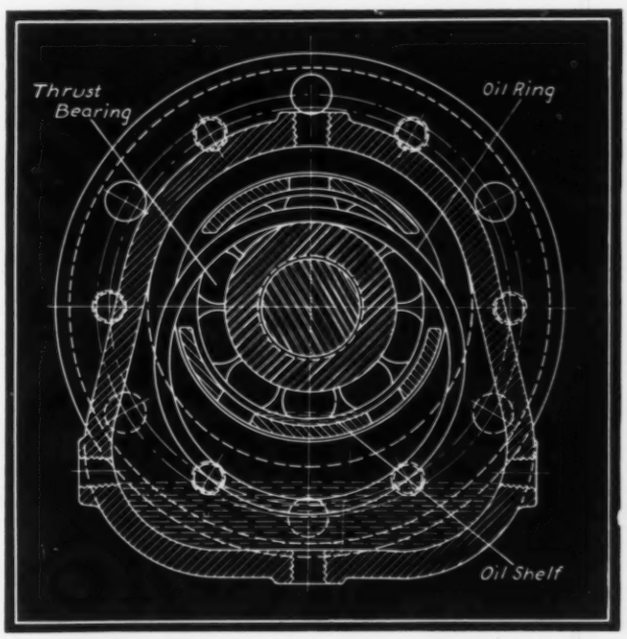


Fig. 1 — Thrust bearing of the ball type employed on centrifugal hot oil pump incorporates an oil ring that carries oil to a shelf by which the proper level is maintained. Excess oil returns to the reservoir below

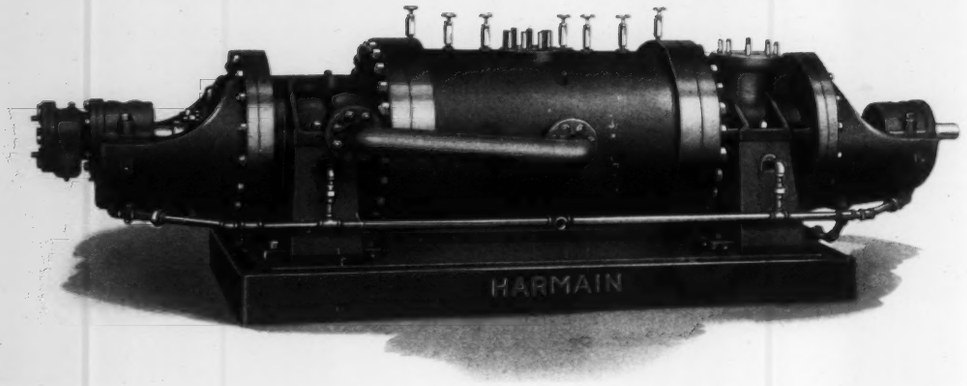


Fig. 2—Compactness characterizes the design of this centrifugal type pump which was developed to take the place of reciprocating units in handling hot oil in refineries. The barrel is made of electric alloy cast steel. End covers are of the same material to obviate unequal expansion

from corrosion-resistant alloys, while the pump blocks or barrels may be constructed from much cheaper material if the difference in expansion between the various parts is not too great.

Selection of materials is only one of many factors which the designer of hot oil pumps must study. Even with materials of equal conductivity and the same coefficient of expansion careful allowance must be made so that no deformation of the machine will be created due to the parts not remaining at similar temperatures. This applies especially to the design of a hot oil centrifugal pump, and certain parts necessarily must be water cooled to give proper operating satisfaction.

Centrifugal Unit Is Compact

With these considerations in mind, Harmain Engineers Inc., affiliated with National Steam Pump Co., Upper Sandusky, O., have developed a centrifugal pump, Fig. 2, for handling oil up to 800 degrees Fahr., with capacities ranging from 150 to 600 gallons per minute and for pressures up to 2000 pounds. From the standpoint of size the completed unit stands in striking contrast to the huge reciprocating pumps formerly used to handle hot oil. Compactness is a natural function of this type of design. There is a distinct saving in the size of the building and the foundations required for installation of the pump, and the equipment can be controlled readily by a flow meter mounted on the main control panel of the operating room.

The sectional view, Fig. 4, shows the web on the lower part of the head which slides in a groove in the foot and retains the pump centerline from side shift on the pump base. These feet which are mounting standards are water cooled from the same system as the main shaft bearings. A second system of water cooling is used for preventing heat from the hot oil from being transmitted along the pump shaft to the main bearing. This operates as follows. Bolted in the end of the pump is a packing box with a gasket at the rear. The water flows around this box, even in the rear of the packing, so that any movement of the oil through the packing must first pass over a cold surface. After the water leaves the packing box, it circulates into the gland and strikes the sleeve on the shaft. Any oil which might leak through the packing passes into this water. The water which is likely to

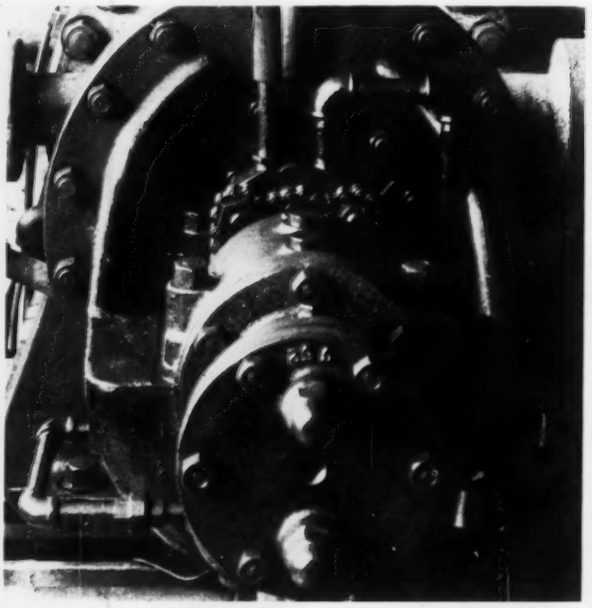


Fig. 3—An endless chain around sprocket nuts insures uniformity in tightening packing gland

come in contact with oil is kept separate from the water that cools the bearings, standards and base so that it can pass to an oil trap. The other cooling water is conducted to an outlet after it has completed its cycle.

Every precaution must be taken in this type of unit to prevent possibility of hot oil escaping. To accomplish this a sleeve on which the packing rides is keyed to the shaft. One end of this special sleeve overlaps a bronze sleeve, Fig. 6, on which the gland rides, forming a small packing box which provides a seal between the shaft and the special sleeve. The bronze sleeve contacts the cooling water but not the hot oil. An auxiliary gland on the front of the primary gland

prevents the water from being thrown by the revolving shaft. Both sleeves can be removed without dismantling the pump.

Primary packing glands are split so that the gland can be removed entirely while adjusting the packing. Adjustment of the gland is accomplished by four bolts, provided with a fine thread on which sprocket nuts are screwed, these nuts being connected by an endless chain as shown in Fig. 3. This insures equal adjustment of all four nuts and keeps the gland parallel with the shaft, requiring the screwing up of only one nut to make the packing adjustment. Thus a great deal of packing trouble is obviated which otherwise might be caused by faulty adjustment.

Cast Steel Barrel Employed

With reference to Fig. 2, disclosing the exterior design, it will be noted that the barrel is of simple cylindrical shape, the outer case of the pump being constructed to withstand high pressure. It is made of electric alloy cast steel, heat treated and quenched to prevent distortion when operating under high temperature. A cast instead of a forged barrel is used because in the first place a casting, in this application, offers less tendency to creep and distort. Moreover, it was desirable to construct both the barrel and headers or end covers of the same material in order to maintain uniformity in thermal conductivity and coefficient of expansion. In view of the complicated design of the end covers, forging of which would be virtually impossible, the casting process offered the best solution.

Suction and discharge openings are separate from the barrel thus eliminating unequal metal sections and simplifying the founder's problem in obtaining a sound casting. Suction and discharge adapters are placed in a vertical position and on the centerline, forestalling vapor binding and simplifying the piping arrangement.

In the case of the pump shown in Fig. 4, this having four stages, two impellers take the oil from the suction entrance and carry it to a pipe by which it is transmitted to the other end of the pump, from whence it is taken by the remaining two impellers to the discharge pipe. In other words this unit is of the opposed impeller type.

End covers are bolted to the barrel with a male and female joint to insure correct alignment under varying temperatures and pressures. These end covers carry on their centerlines the supporting brackets of the pump. Because suction is applied at one end of the pump, only the pressure thus created is carried on the packing at that end. The end cover opposite the suction opening carries only half the pressure of the pump inasmuch as half the number of impellers finally force the oil to the discharge opening. Between the packing box on this end and the pressure chamber a valve is installed, and between this valve and the packing box there is a return pipe to the suction end, so that the packing on the end opposite the suction opening has but little more than suction pressure. Any oil which might leak past the valve is, of course, returned through the equalizing pipe to the suction opening.

Opposed Impellers Solve Problem

Difficulty is experienced in the design of a multi-stage centrifugal pump in taking care of the end thrust. However, the opposing of the impellers tends to solve the most difficult part of this problem. In a pump which is designed for opposed impellers and is fitted properly, the pump will operate without thrust with the ex-

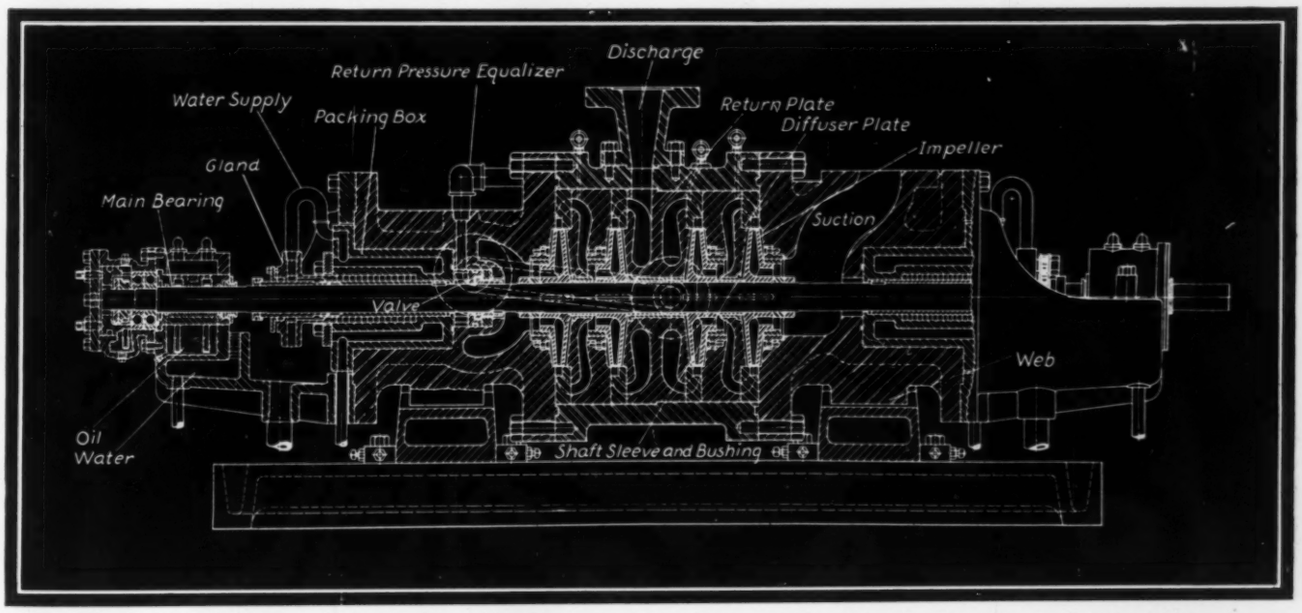


Fig. 4—Section through 4-stage centrifugal pump shows arrangement and mounting of opposed impellers

ception of minor surges caused by uneven fluid flow.

The thrust bearing, of the ball type, Fig. 1, is required to take only the surges from the flow, and is capable of withstanding the most severe thrust this pump could impose. It is, however, loaded lightly under normal conditions. Most ball bearings suffer from either too much or too little oil; the design of this bearing is one method of solution. The bearing is ring oiled which is unusual, many bearings being designed to dip in the oil. It is hard, however, to design a proper pocket for the bearing to dip into and at the same time retain a proper oil level. This bearing actually dips into the oil, but the level is separate from the reservoir below the bearings, and is maintained continually on a shelf by the action of the ring and overflow as depicted in Fig. 1. Main radial bearings are of the sleeve type, made from lead bronze alloyed for high speeds; they are water cooled and lubricated by two large rings in each bearing.

Hot Oil Presented Bearing Problem

Design of the shaft which carries the impellers presented one of the most difficult problems encountered in the development of the unit by reason of the fact that the shaft is required to rotate in the hot oil being pumped. This necessitates bearings which will function satisfactorily under these conditions. Sleeves of a nonferrous alloy offering high resistance to abrasion fastened on the shaft and running in special alloyed cast iron bushings finally were selected.

Impellers and shaft sleeves are not forced on the shaft, but can be slipped on and off easily by hand. Aside from being readily removable from the shaft there are other reasons for this method of fastening. Strains tending to distort or bend the shaft would be caused by an impeller with a tight key, and the mechanical balance of the impellers could not be maintained if they were thus fastened to the shaft.

Opposing of the impellers and the shoulder in the pump barrel allows sealing of the return plates, Fig. 4, by the diffuser plates which act as sealing surfaces on the side of each return plate. These surfaces are held tightly by the liquid pressure acting on the plates and it therefore is unnecessary to fit the entire surfaces of the peripheries of the return plates to the barrel to prevent leakage. The return plates are supported in the barrel by small raised portions which are provided for holding them concentric with the barrel while facilitating easy withdrawal in disassembling the pump.

In addition to the features of compactness, ease of assembly, etc., the pump was designed to be of the centrifugal type rather than the reciprocating for the following reasons. Action of the surge of a plunger pump is but little understood. The difficulty lies in the high pressure set up by elastic oscillations produced first by plunger action. If the pressure variations produced by these elastic oscillations find no reflecting point, they will die out. If, however, they are reflected in any manner from any point in the line, the resultant pressure will depend on the phase relation of the incident and reflected waves, with the inertia effect added, and high pressures will be produced. These pressures have frequencies too high to be registered on a pressure gage and consequently they seldom are recognized even by the trained engineer. The troubles caused by this action often are attributed to faulty material in tubes and headers. Employment of the centrifugal principle solves this problem of oscillation as well as many other difficulties not thoroughly understood by engineers.

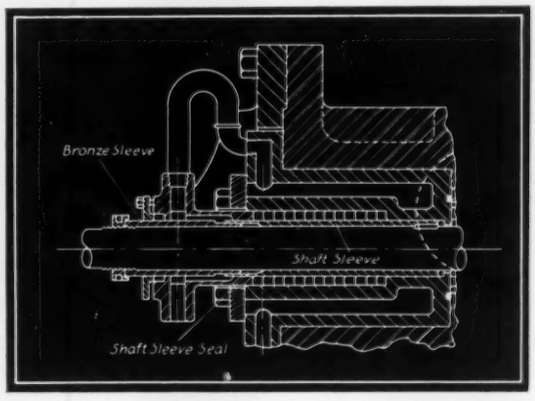


Fig. 6—A special sleeve overlapping a bronze sleeve provides a small packing box for sealing

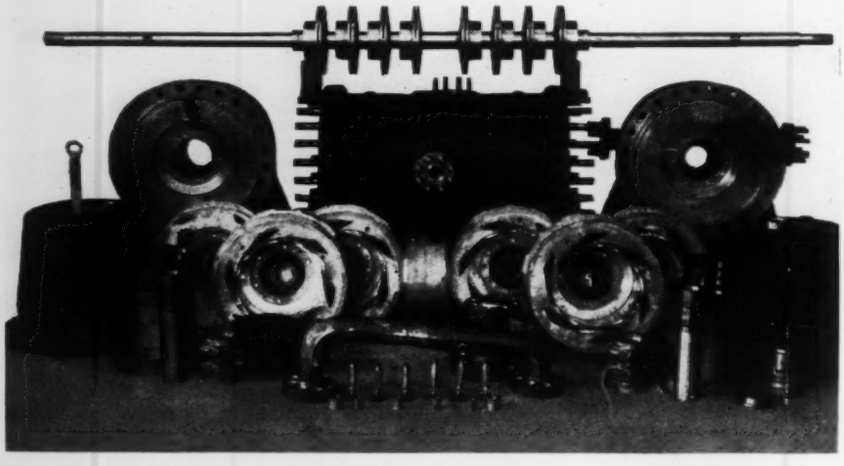


Fig. 5—Exploded view showing parts which make up 8-stage pump

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Machine Parts of Powdered Metal

POWDERED metallurgy utilizing metals in the powdered rather than molten state is winning the attention of engineers. The new method not only makes possible the manufacture of oilless bearings of heavy load carrying capacity but the fabrication of other machine parts from common alloys. Mixtures of metals which would be difficult to pour because of their difference in melting points or their chemical reactions have possibilities when processed in powder form.

Instead of being poured into molds metals can be shaped at low temperatures by powdered metallurgy. One advantage of objects made by this process is their lightness. Inasmuch as the finished part is in effect a metal sponge, its specific gravity is considerably less than solid metal, though with almost no difference in strength. At present the greatest obstacle to development of this practice is the difficulty of making large objects. As the diameter or area of the article increases, the total pressure required also rises considerably.

Processing of the powdered metal part is performed by mixing, briquetting, heat treating and finishing. Heat treating is carried out by the sintering method which means that the temperature exceeds the melting point of only one of the elements. In the case of the graphited bushings, Fig. 1, produced by the Amplex Mfg. Co., Detroit, the temperature exceeds the melting point of the tin but does not approach that of the other constituent, copper. Powdered copper for bearing requirements is made from two processes, namely, by the reduction of pure copper oxide and pulverizing, or by electroplating in the form of "rotten copper."

Develops Self-Consuming Welding Rod

INDUSTRY is looking to welding processes for faster and more economical means of fabrication of machines and their components. A specific instance in which a pioneer manufacturer saw this movement taking place lies in the development of a new welding process by Champion Rivet Co., Cleveland. The method consists of a simple arrangement which holds a self-consuming welding rod against the joint to be welded.

Electrical control devices are practically eliminated. The paste-coated rod is laid down in the angle formed between the sections to be welded and the current applied through a series of electrical contacts which are made by arms extending from a bus bar. Several years ago self-consuming rod was originated for welds up to about 18 inches in length; with the new process, however, welds of any length can be made. Included in the applications to which the process is expected to be suitable are the manufacture

Fig. 1—Pure copper in the powdered form constitutes the basis of the oilless bushings depicted in center. Spring disks as shown at ends also are manufactured by the process involving powder metallurgy

of steel tubing, production of frames for large machines, oil storage tanks, etc. Steel building construction also holds promises for its use.

Controlling Temperature of Oil

LUBRICATION effective to the highest degree is obtainable only when the oil temperature is regulated if the equipment is subjected to contrasting temperature changes. This condition applies particularly to automobiles which are required to operate under varying weather conditions. From this standpoint and in view of the increasing attention being paid to lubrication of machinery, Leon Cammen, New York, has developed an oil temperature regulator, Fig. 2. The device consists of a heat exchanger with oil flowing through tubes and water circulating in the space in the casing surrounding them.

When the cold engine is started the water heated in the engine jacket passes through the casing as indicated by the arrows in the top drawing, Fig. 2. The oil consequently acquires a higher temperature from the warm water in the casing. After the oil in the crankcase reaches the desired working temperature a thermostatic device combined with the oil filter, moves three valves, *a*, *b* and *c* of the heat exchanger through an angle of 90 degrees. At this point the water cooled in the radiator passes through the heat exchanger as indicated by the arrows in the lower drawing.

Reversal of the water circuit thus heats the oil when the engine is cold and cools it when hot. Mr. Cammen claims that in his oil temperature regulator the oil is heated up to 100 degrees in two or three minutes, whereas earlier devices have been much slower in action.

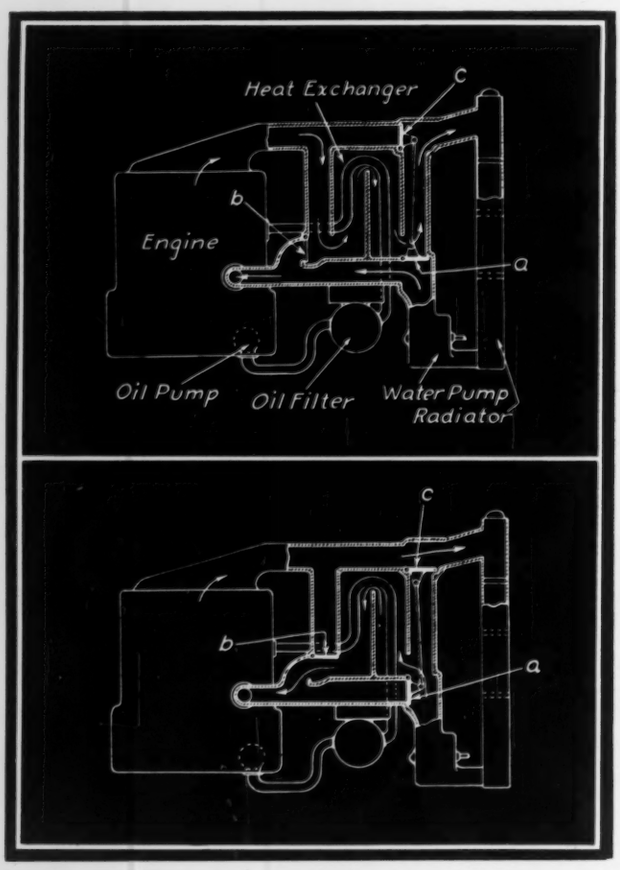


Fig. 2—(Top)—Position of valves in oil temperature regulator when engine is cold. (Bottom)—Valves change position to cool oil of heated engine

Counter Currents Mix Materials

UNLESS careful study is given to the directional characteristics of the currents set up by the moving blades in a mixing machine there is possibility of failure in securing a perfect mixture. One efficient unit of this type, a counter-current rapid batch mixer, now is being manufactured in this country under the Eirich patent by Lancaster Iron Works, Lancaster, Pa.

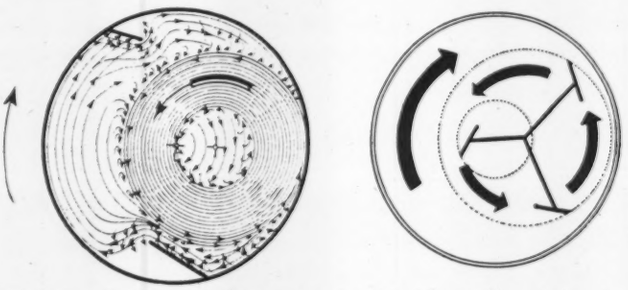


Fig. 3—Diagram at left shows direction of currents in mixer. (Right)—Layout of single star unit

Mixing arrangement consists of an open or enclosed type pan, rotating on four trunnion wheels, which feeds the batch continuously to the mixing star, turning in the opposite direction. As shown at the right in Fig. 3, this being the single star model, the mixing star is eccentric to the pan and is provided with a number of spring-mounted steel blades placed in such a manner as to give the maximum number of points of intersection during its rotation.

Speed of the pan to the mixing star is 1 to 5. The thin layer of material in the pan is carried by the counter-current action at a moderate speed toward the rapidly rotating mixing star. The diagram at the left, Fig. 3, shows that at the points of intersection of both movements at the periphery of the mixing blades, the batch materials are turned on vertical axes. The effect is increased considerably by the vertical side scraper and corner blades which are stationary, thereby forcing the batch through a narrow passage.

Filament Coil Less Than Hair Size

TUNGSTEN filament wire used in the six-watt incandescent lamp is so fine it is practically invisible, being only four ten-thousandths of an inch in diameter. After it is coiled, 1390 turns

per linear inch, to form the spring-like filament through which the electricity flows to produce light, the outside diameter is less than that of a human hair.

All six-watt filament wire employed in the Westinghouse lamp is drawn from a bar of tungsten metal 3/8-inch square, 24 inches long and weighing 1-1/3 pounds. The bar passes through 95 dies, each with an aperture slightly smaller than the preceding one. Nearly two-thirds of these dies are rough cut diamonds in which holes have been drilled.

When being drilled the diamonds are placed in revolving spindles, and extraordinarily hard steel needles, dipped in diamond dust, press against them at the center. The hole is conical in shape and is drilled half-way through both sides of the diamond. Where the apex of each cone meets, barely enough to break through, the tiny hole forms the die.

Utilizing Box-Type Construction

BOX-TYPE construction to attain rigidity in machine construction is a feature no designer should overlook when the unit being planned or considered for redesign lends itself to this type of layout. The setup becomes even more desirable when a brace for example can be utilized for the lubrication reservoir as in the new Gridley four-spindle automatic, Fig. 4, just announced by National Acme Co., Cleveland. The

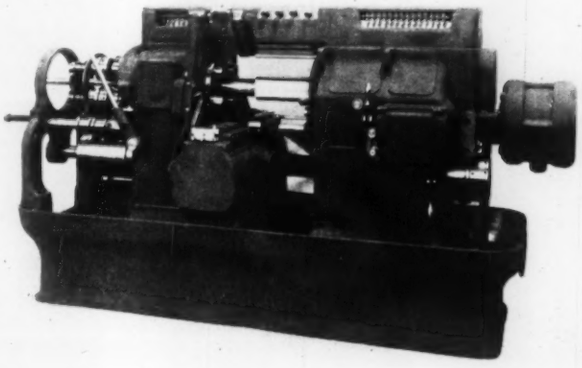


Fig. 4—Top brace is of rigid box-type construction and provides oil reservoir for lubrication system

frame and pan of the new model also are of box form, with a heavy top section to tie the gear section to the spindle frame, making the entire machine a rigid unit.

Forced feed automatic lubrication independently controlled to each bearing is an outstanding characteristic. The system which accommodates all parts of the machine, employs a lubricating pump located in the top section directly over the gear box to force oil to a series of visible oilers. From there a separate copper tube is connected to each bearing. When the unit is stopped the pump discontinues supplying oil to the visible oilers; consequently there is no waste of lubricating oil while the mechanism is idle, even though the oilers may be open.

Porcelain Affords Protective Coating

APPLICATION of porcelain similar to that used on plumbing materials, for coating the component parts of deep well turbine pumps, is a development which engineers of the Johnston

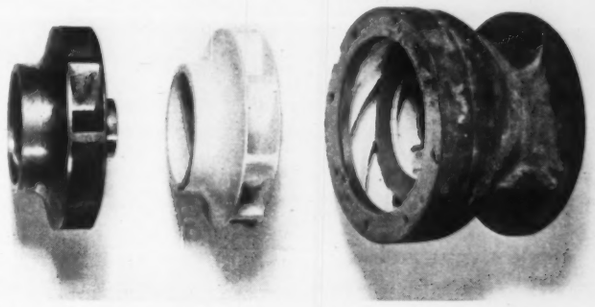


Fig. 5—Porcelain enamel is used for protecting centrifugal pump impellers and bowls from acids and abrasives

Pump Co., Los Angeles, have been studying for several years. Recently the company announced that it had devised an ingenious method whereby the impellers and bowls, Fig. 5, can be coated evenly. The porcelain coating is said to increase the efficiency of pumps approximately 5 per cent in addition to being completely acid and abrasion resistant.

Pump impellers and associated parts as a rule give pump manufacturers more or less trouble in selection of materials. Modern industrial requirements call for units that will handle liquids such as acids, hot oil, water containing abrasives, etc., all of which demand pump materials that will resist destructive effects. As brought out by the Johnston company, it has been necessary for manufacturers to rely almost solely on castings from which it has been difficult to obtain pump runners with an absolutely smooth wear-resisting surface, not merely on the exterior, but throughout the runners and bowls. It is believed that porcelain enamel coating will prove the solution and patents to cover the method have been applied for. Surface tension characteristics of the porcelain, when in a molten state, cause it to flow into the pores of the iron and produce a glass-hard, glass-smooth surface.

Although a separate Schwitzer-Cummins supercharger was used (page 24, October issue) on each bank of cylinders on the multiple engines employed on Gar Wood's record breaking speed boat, MISS AMERICA X, a single carburetor common to both banks was utilized for each engine.

Correcting for Fluid C in Hydraulics

By James I. Clower
and
Harold F. Shepherd

IN TIMES past only physicists and other scientists were concerned with the compressibility of liquids. This question, however, is no longer a matter of purely academic interest since the attention of the engineer has been attracted forcibly to it by the following factors:

Rapid development of the diesel engine

Comparatively recent introduction of hydraulic drives and feeds to various machines, stimulated greatly by development of the constant speed, variable stroke pump

Demand for high speed hydraulic presses

Various research investigations on the viscosity of oils subjected to high pressure.

Today, engineers are giving more consideration to the fact that considerable pump displacement, time or energy may be expended in compressing the liquid used as a hydraulic medium. One or the other of these losses may be harmful or the three factors may add collectively to the first cost, the operating cost or the output of hydraulic apparatus.

It has been assumed quite generally that the specific volume of a liquid does not change appreciably when subjected to pressure and hence the equation $W = PV$ has been used for calculating the hydraulic work where,

W = work of displacement per pound of fluid
P = pressure increase
V = initial specific volume

The diagram at left in Fig. 1 is characteristic of these relations within the pump or motor cylinder when handling an incompressible fluid.

This equation is not sufficiently accurate for all conditions. Water, it has been stated, is approximately one hundred times as compressible as steel and fifteen times as elastic as mercury. Many oils are rather more compressible than water when subjected to the same conditions of pressure and temperature.

This characteristic requires work of compression upon the liquid before it is possible to effect the work of displacement. An indication of this is given at right in Fig. 1. Fuel compressibility is a vital matter in diesel engine design. Dr. Diesel had to abandon direct injection of fuel and to blow the fuel in with air because in his lifetime the hydraulics of solid fuel injection were not developed.

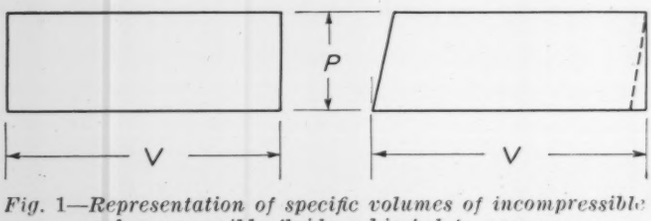


Fig. 1—Representation of specific volumes of incompressible and compressible fluids subjected to pressure

In the present solid injection diesel engine the fuel is raised to the required discharge pressure of 4000 to 6000 pounds per square inch by cam-operated pumps. Fig. 3 shows schematically the system which serves to meter and inject the small charges of fuel. The fuel pressure opens the nozzle valve c which it tends to eject from its bushing, this force being resisted by spring d. Often from one-fourth to one-half of the plunger displacement is required to compress the fuel to the discharge pressure.

TABLE I
Coefficient of Compressibility of Water

Temperature Degrees Cent.	Pressure Atmosphere	Compressibility per Unit Volume per Atmosphere
0	1 — 25	52.5×10^{-6}
10	1 — 25	50.0×10^{-6}
20	1 — 25	49.1×10^{-6}
0	25 — 50	51.6×10^{-6}
10	25 — 50	49.2×10^{-6}
20	25 — 50	47.6×10^{-6}
0	100 — 200	49.2×10^{-6}
10	100 — 200	46.1×10^{-6}
20	100 — 200	44.2×10^{-6}
50	100 — 200	42.5×10^{-6}
100	100 — 200	46.8×10^{-6}
0	1 — 500	47.6×10^{-6}
20.4	1 — 500	43.4×10^{-6}
48.85	1 — 500	41.6×10^{-6}
0	500 — 1000	41.6×10^{-6}
0	1000 — 1500	35.8×10^{-6}
20.4	1000 — 1500	33.8×10^{-6}
48.85	1000 — 1500	32.5×10^{-6}
0	1500 — 2000	32.4×10^{-6}
0	2000 — 2500	29.2×10^{-6}
0	2500 — 3000	26.1×10^{-6}
48.85	2500 — 3000	25.4×10^{-6}

Like most adverse properties of material, com-

Compressibility

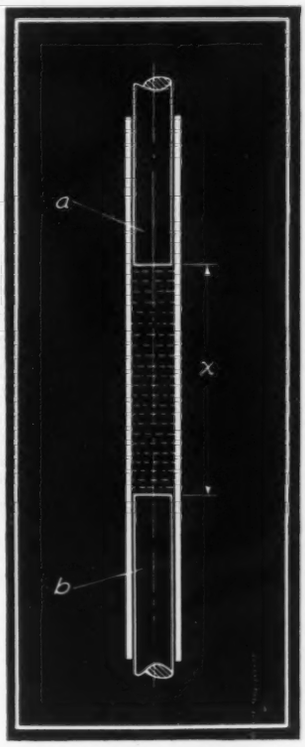


Fig. 2—Simple plunger moving in an endless cylinder at constant velocity characterizes any multicylinder hydraulic pump

pressibility may serve the designer's purpose in some ways. The diesel engine fuel pump designer takes advantage of the interval of fuel compression to accelerate the fuel pump plunger from rest to the speed required for constant pressure injection through the fixed nozzle orifice.

Unless checked by some feature of the design, discharge continues by expansion of the compressed fuel after the plunger movement has ceased. This action is avoided by use of a bypass valve actuated by the pump plunger.

Pumps for fuel injection are a special design problem but possibly the studies of liquid compressibility made in perfecting their design may be of use in planning other hydraulic apparatus.

A. E. H. Love (see bibliography) has stated, "the elasticity of a fluid is always expressed by means of a single quantity of the same kind as the modulus of compression of a solid body. To any increment of pressure which is not too great there corresponds a proportional cubical compression, and the amount of this compression for an increment δp of pressure can be expressed as $\delta p/k$. The quantity that usually is tabulated is the reciprocal of k, and it is called the coefficient of compressibility. It is the amount of compression per unit increase of pressure. As a physical quantity it is of the same dimensions as the reciprocal of a pressure (or of a force per unit of area). The pressures concerned usually are measured in atmospheres (1 atmosphere = 1.014×10^6 dynes per square centimeter). For water the coefficient of compressibility, or the compression per atmosphere is about 4.5×10^{-5}. This gives for k the value 2.22×10^{10} dynes per square centimeter. Young's modulus and the rigidity of a fluid are always zero."

It is to be noted that the modulus of compression, even that of a solid, is a quantity "of the same kind" as Young's modulus but not numerically equal to it as has been stated in some works on hydraulics. Again quoting from Love, this time regarding solids, "the modulus of compression k of an isotropic material is connected with the Young's modulus E and Poisson's ratio σ of the material by the equation

$$k = (1 - 2\sigma)\ E/3$$

Thus the bulk modulus or modulus of compression of steel is given in the Smithsonian Physical Tables as 21.61×10^5 and not as 30,000,000 pounds per square inch, the value often used in comparing the compressibility of steel and water in engineering handbooks.

Love qualifies his statement regarding the proportionality between applied pressure and compression to "any increment of pressure which is not too great." If early experimenters had conceived the necessity of extending their researches to the extremely high pressures in commercial use today, we might not have been taught that the coefficient of compressibility is in any wise similar to Young's modulus.

Table I shows the coefficient of compressibility of water under various conditions. From this it is quite evident that the values given are averages for the range of each experimental test. Compressibility of water as well as that of oils and other liquids varies with temperature and pressure, in a general way decreasing as both temperature and pressure increase. Our present sources of information give only average values at a few temperatures for certain pressure ranges and note a few idiosyncrasies such as the fact that water shows a minimum compressibility at about 50 degrees Cent.

TABLE II

Properties of An Average Fuel Oil

Pressure Range Atmospheres	Compression per Unit Volume per Atmosphere
0 — 51	60.7×10^{-6}
0 — 102	53.4×10^{-6}
0 — 153	50.7×10^{-6}
0 — 205	48.5×10^{-6}
0 — 256	49.7×10^{-6}
0 — 306	49.4×10^{-6}
0 — 352	48.2×10^{-6}

D. E. Alexander derived the date from which Table II is made for an average sample of fuel oil which is used often as a hydraulic medium because of its cheapness and nonfreezing properties.

The compressibility of petroleum fractions

varies rather greatly and inversely with their gravity. Thus Bartoli gives for the range 0-1 atmosphere the value 159×10^{-6} for C_6H_{14} (Hexane, a light constituent of gasoline) and 75×10^{-6} for C_6H_{34} (Hexadecane, a constituent of any paraffin base fuel oil). These values are at 23

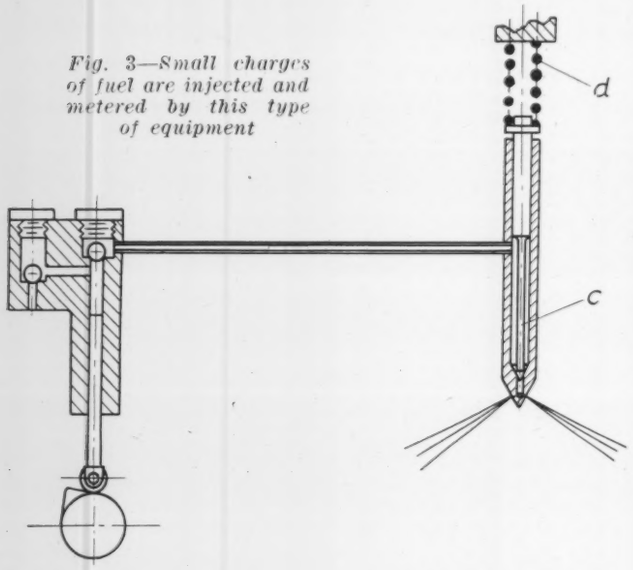


Fig. 3—Small charges of fuel are injected and metered by this type of equipment

degrees Cent. However, the Alexander table will serve any technical purpose.

Glycerin is the least compressible of fluids used for hydraulic work but no adequate tables seem to exist. Quincke is the authority for value 25×10^{-6} at 20.5 degrees Cent. No pressure range is mentioned. The value 22×10^{-6} at 14.8 degrees Cent. is given by deMetz also without reference to pressure.

Mercury which might have some possibilities for small and exacting mechanisms is comparatively inelastic. The value 3.92×10^{-6} at 0 degrees Cent. is given by Amagat.

Table III shows general physical and chemical properties of a number of liquids which might be used as hydraulic mediums. Certain of them for instance water, castor oil and mineral oil *D* may be chosen by the designer for his work. It is then desirable to make a general empirical formula of sufficient accuracy for ordinary design purposes. One of these may be derived as follows. Taking the higher values of the three liquids suggested.

Water 390,000
Castor oil 380,000
Mineral oil *D* 350,000

we find the average modulus to be 373,000. Then the following is true

$$S_f = \frac{1}{373{,}000} p + S_o$$

where

S_f = specific gravity at pressure p
p = pressure in pounds per square inch
S_o = specific gravity at atmospheric pressure

Furthermore, it is obvious that the change in volume is inversely proportional to the change in specific gravity. Hence, the final volume may be determined by means of the following equation

$$V_f = \frac{V_o \times S_o}{S_f}$$

where

V_f = final volume
V_o = original volume
S_o = original specific gravity
S_f = final specific gravity

Equating V_o equal to unity then combining these two equations and solving for final volume,

$$V_f = \frac{373{,}000\ S_o}{373{,}000\ S_o + p}$$

The foregoing equations are applicable to liquids in which the temperatures do not exceed 400 degrees Fahr. Above this temperature, the isothermal curves derived from these equations and shown in Fig. 4 deviate considerably from straight lines.

The elementary conception of hydraulic transmission is the simultaneous translation of the motion of one moving element, the pump to another, the motor, the connecting link being a fluid. The relative velocities of the pump element and the motor element vary as their piston areas, the displacements being necessarily equal. Length and diameter of the ducts connecting the two units may suit convenience.

Actually if the size of the pump and motor units is to be kept within reason with regard to cost, space and appearance, it is essential to use reasonably high pressures. This necessity exaggerates the effect of compressibility and for practical purposes makes a fallacy of the old saw, "liquids are practically incompressible."

Any multicylinder hydraulic pump may be replaced for purpose of demonstration by a simple plunger moving in an endless cylinder at constant velocity. Fig. 2 may be used as an example.

At slightly above zero pressure infinitely slow movement of plunger *a* will be followed by ex-

TABLE III

Volume Modulus of Elasticity

Substance	Temperature, degrees Fahr.	Volume modulus, pounds per square inch	Absolute viscosity poises
Water	60	$0.32 - 0.39 \times 10^5$	0.01
Fixed Oils			
Castor	104	$0.28 - 0.38 \times 10^5$	1.820
Trotter	104	$0.26 - 0.33 \times 10^5$	0.344
Rape seed	104	$0.26 - 0.34 \times 10^5$	0.375
Sperm	104	$0.24 - 0.32 \times 10^5$	0.154
Mineral Oils			
Oil *A*	104	$0.30 - 0.37 \times 10^5$	1.770
Oil *B*	104	$0.28 - 0.34 \times 10^5$	0.495
Oil *C*	104	$0.28 - 0.35 \times 10^5$	1.415
Oil *D*	104	$0.28 - 0.35 \times 10^5$	0.470
Oil *E*	104	$0.28 - 0.25 \times 10^5$	3.240

Oil A is an extra-heavy bodied bearing oil.
Oil B is a heavy-medium bodied automobile oil.
Oil C is a heavy-bodied automobile oil.
Oil D is a light-bodied general purpose oil.
Oil E is a very heavy-bodied compounded steam cylinder oil.

Note: A compounded oil is a mineral oil containing a small percentage of fixed oil.

actly equivalent movement of b transmitted by the fluid contained between a and b. If tangible resistance is opposed to the movement of b pressure must be built up on the fluid by force applied to a. This implies work and to effect work both force and movement of a are required before it is potentially able to overcome b.

Assuming that the plunger and duct areas are uniformly one inch square and that the resistance opposing b is 1000 pounds, a then will be required to build up a fluid pressure of slightly over 1000 pounds to set b in motion. Let us assume further that the distance x is six feet or 72 inches. a will be required to move a distance

$$\frac{1000}{14.7} \times \frac{53.4}{1{,}000{,}000} \times 72 = 0.26 \text{ inches}$$

before motion of b starts if fuel oil is the hydraulic medium.

If the resistance at b is the result of its motion as in feeding a drill into work the pressure will build up to full feed thrust only after the pump element has advanced 0.26 inches. As the drill passes through the work the ram will be advanced 0.26 inches by fluid expansion alone.

If the pump and motor elements were ten times as great in area and the fluid pressure one-tenth as much the lag and bursting through of the drill would be reduced in proportion to the pressure.

Gradual acceleration of work also is accomplished best by gradual admission through the control valve rather than through fluid elasticity which in machines that "cut out" at the end of their traverse always causes undesirable acceleration when least desired. Feed rates may be controlled by throttling the discharge of the opposed or returning cylinders. Ingenious commercial valves are available for this purpose.

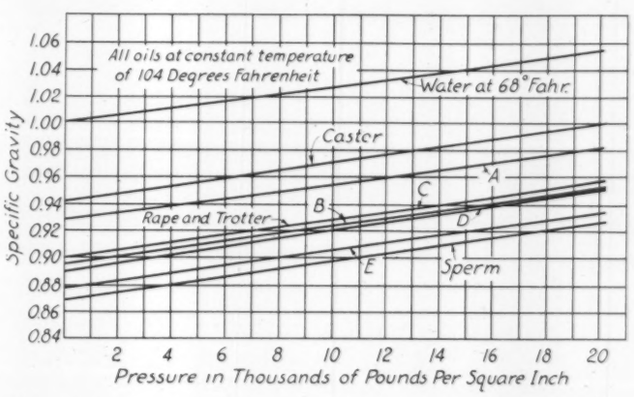


Fig. 4—Specific gravity of liquids increases with pressure

Most evils resulting from compressibility in hydraulic systems are due to large clearances in pumps and hydraulic cylinders and large volumes of fluid in piping. While the work of compression adds only a small area to the work diagram of any single pump cycle of unit discharge volume it may add a great deal to the work of a press cycle and according to Walter Ernst (see bibliography), to the time required to complete this cycle. If the volume of fluid contained in the ducts and in the hydraulic press cylinder equals, for example, fifty times the volumetric displacement of the ram which may be working on a short stroke job while considerably extended from the cylinder, compressibility will require $218 \times 0.000{,}048 \times 50 = 0.5$ times or ½ the time and pump work required for the actual press work if fuel oil is used as a medium at a pressure of 3200 pounds or 218 atmospheres.

Keenan has shown that more than 7500 foot pounds of energy are required to compress a pound of water from atmospheric pressure and displace it against a head of 3200 pounds per square inch. And, when it is realized that this 7500 foot pounds of energy may originate from a prime mover where approximately 300,000 foot pounds of fuel energy are required to produce it, it is evident that the work of compression should not be ignored.

Harmonic Oscillations Developed

Comparatively frictionless hydraulic apparatus develops harmonic oscillations of the motor plunger and load on the elastic transmission medium in definite and calculable frequencies. The friction of machine platens and carriages on their sparsely lubricated ways is effective in damping this vibration but advance by steps due to correlation between compressibility and the friction of rest and that of motion is always possible if the system is too elastic.

This action may be illustrated by dragging a weight across a surface plate with a light spring. It is quite impossible to make the weight move at uniform velocity.

This latter consideration calls for a minimum of liquid in the working part of the system, therefore selection of the most desirable operating pressure may call for first class engineering judgment as it involves so many factors of both mechanical and economic nature.

Bibliography

Love, *Encyclopedia Britannica* (Eleventh Edition).

Smithsonian Physical Tables. Sixth Revised Edition. Table 56.

Amagat, *Ann. chim. phys.* (6) 29, 1893.

Kaye and Laby, *Physical and Chemical Constants*, 1911.

Alexander, "Airless Injection of Fuels," *Transactions Institute of Marine Engineers*, London, vol. 39. p. 366. 1927.

Bartoli, *Rendus Lomb.* (2) 28, 29, 1896.

Quincke, *Wied. Ann.* 19, p. 401, 1883.

Keenan, *Mechanical Engineering*, Feb. 1931.

Ernst, "Influence of Oil Compressibility on Speed Characteristics of Hydraulic High Speed Presses," Paper presented at Buffalo meeting, American Society of Mechanical Engineers, Oct. 3, 1932.

Hyde, "On the Viscosities and Compressibilities of Liquids at High Pressures," *Proceedings of the Royal Society of London.* vol. 97. 1920.

Heck, "Compression of Liquid Water," *Power.* Sept. 22 1931.

Know Your Shop!

Digest of Papers Pertinent to Design Presented During the Metal Congress

CORRELATION of design and production is a significant factor in modern engineering. Increased flexibility and versatility in machine tools are required to meet the designer's needs. These expressions of opinion were given at the production meeting sponsored by the Society of Automotive Engineers during the recent National Metal congress held at Buffalo. The former statement was made by Alex Taub, Chevrolet Motor Co., and the latter by L. F. Maurer, Pierce Arrow Motor Car Co. Papers delivered by both engineers curiously enough, covered similar phases of design and production activity.

Advancement in engineering standards has created, according to Mr. Taub, the need for increased production ingenuity. Refinements in design are useless unless the machine shop can hold dimensions accurately; we must have rugged accuracy without fixed centers. The fact has become increasingly evident that the engineer should know his shop and shop man in order to temper his suggestions to prevailing conditions. On the other hand the shop man, by his intimacy with engineering test results, can see the parts he is producing in the light of their functioning.

Hydraulics, the application of which has characterized one of the more recent trends in design of machinery, provided the background for a discussion on the influence of oil compressibility on speed characteristics of hydraulic high speed presses. The data was presented by Walter Ernst, Hydraulic Press Mfg. Co., Mt. Gilead, O., at the machine shop practice division of the American Society of Mechanical Engineers.

Lists Advantages of Hydraulics

Some of the advantages of hydraulics stressed by the speaker include accuracy of control of forces as to magnitude, direction and speed; smooth action of the driven apparatus; flexibility and versatility of the machines on which the hydraulic systems are applied; economy in design, high efficiency and overload protection.

Discussing technique of size control in precision grinding operations, R. E. W. Harrison, Cincinnati, claimed it is an unfortunate fact that some designing engineers are not sufficiently informed regarding the accuracy and producing possibilities of new machine tools; hence the frequent assignment of limits which, if adhered to, would inflate the costs and also result in the limits being taken by the shops as a guide only and ignored, with consequent increase in the cost of assembly and occasional faulty functioning.

The design angle on grinding problems is of paramount importance, Mr. Harrison said. As an example he pointed to an article of general household use that was designed with over twenty component parts calling for limits of accuracy within a total tolerance of two-tenths of one thousandth of an inch. The experimental models were made in a tool room where no accurate records of the costs were obtained. Moreover, there was undue optimism regarding the capabilities of the machine tool equipment to produce the components rapidly to the prescribed limits of accuracy and at a low cost. A vast quantity of work was put into progress, but when it was in its final stages of manufacture the real difficulties arose.

Redesign Overcomes Difficulty

As is usual in a manufacturing scheme of this kind the inspection department reported directly to the management and the inspectors demanded from the production lines, limits of accuracy in accordance with the figures set down by the engineering department. The whole scheme reached a deadlock and the tangle was solved eventually only by a redesign of the major units. Proper functioning was obtained with two parts made to the fine tolerances and the remainder of the parts to commercial limits with a tolerance of 0.0005-inch on each piece.

Generally speaking engineers can be employed who are capable of designing mechanisms which will perform any reasonable function under almost any condition, but the genuine engineer is the man who can design equipment which will achieve the desired results, with the minimum number of parts, made to maximum tolerances.

Other societies and divisions participating in the metal congress were the iron and steel division of the American Society of Mechanical Engineers, American Society for Steel Treating, American Welding Society, American Institute of Mining and Metallurgical Engineers, Wire Association, and American Drop Forging institute. New products and equipment exhibited at the exposition reflected the efforts of manufacturers to meet the demands of lower costs, more efficient production and superior quality which have been imposed by the depression.

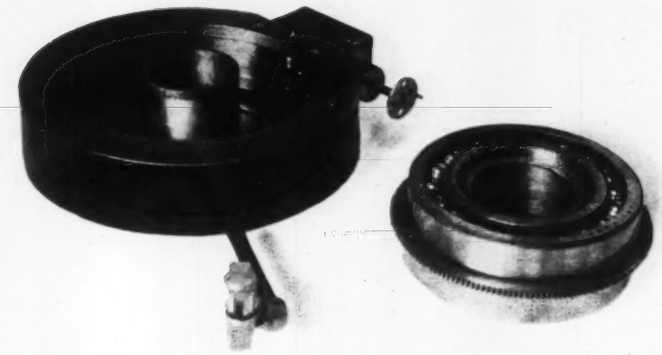


Fig. 1—Worm for driving bearing is coupled to a fractional horsepower motor which drives from the side

Reducing Friction in Antifriction Bearings

By Thomas Barish

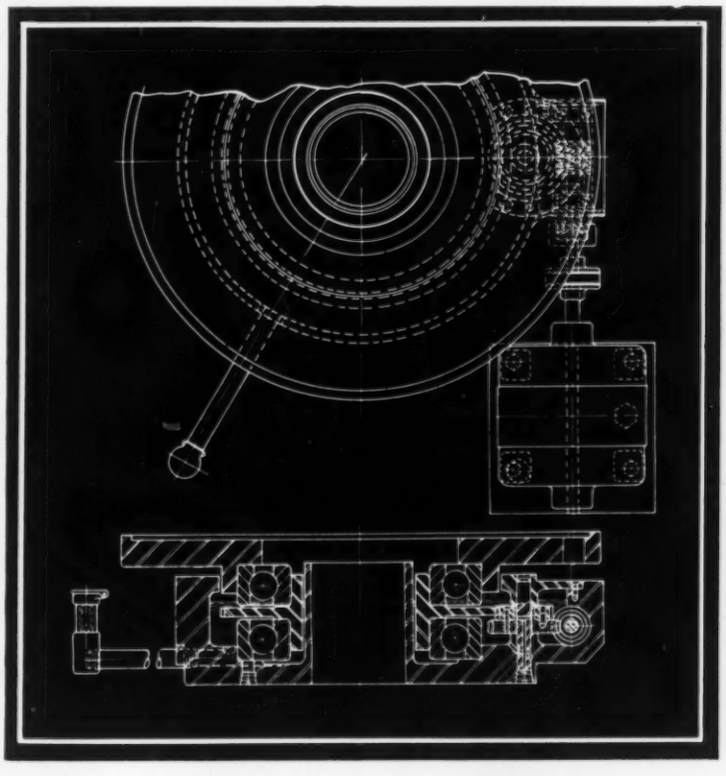


Fig. 2—Special arrangement of bearing used to overcome friction and provide accurate measurements on equipment

FEW designers realize that ball and roller bearings have a definite and measurable frictional resistance even though they are called antifriction bearings. This frictional resistance is small compared to that of the usual sliding or plain bearing, but nevertheless it does exist and has some clearly defined characteristics. In the first place, there is little variation over wide ranges of speed and load for any one bearing. On the other hand, there are considerable changes among the bearing types. The common ball thrust bearings have less friction than radial ball bearings because of their internal design.

Furthermore, any particular type of antifriction bearing can have its frictional resistance reduced by modifying the design of the parts. In a ball bearing this usually entails a loss in capacity; in a roller bearing, closer tolerances.

Occasionally a machine design problem arises calling for a study of the small friction of ball or roller bearings. Usually this is a heat problem, although heat is caused most often by other things—excessive preloads, excessive lubrication, off-square conditions or rubbing parts.

Ball bearing friction now is being utilized to measure preloads on machine tool spindles. The coefficient of friction of the present day ball bearing is approximately 1/600 under

thrust load. A preload can be determined by measuring the drag or friction; that is, how much weight at any radius is necessary to keep the spindle turning once it is started. This factor may be expressed as

$$Preload = \frac{inch\ pounds\ drag}{pitch\ radius\ of\ bearings} \times 600$$

Usually this is divided by two because the same load is applied on each of the two opposed bearings.

Described in the following is a special machine problem which required an unusual arrangement to eliminate the effect of the small

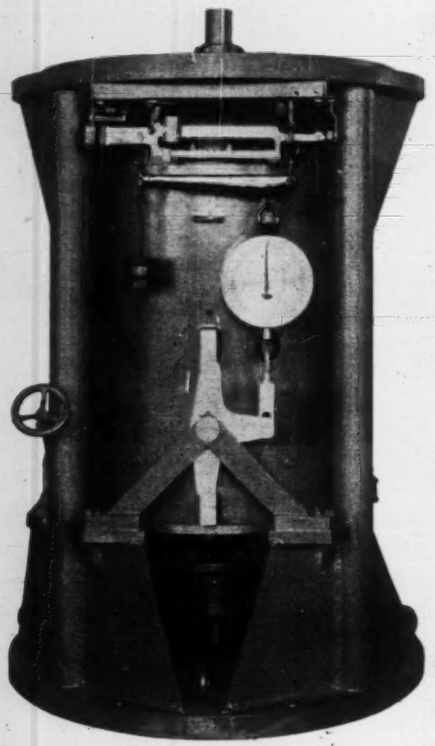


Fig. 3—Extreme sensitivity was required for measuring slight change in efficiency with this dynamometer used for testing water wheel design

but definite ball bearing friction. A large dynamometer (300 horsepower 1325—2500 revolutions per minute) was set up vertically for special development work on a new hydroelectric plant at the Holtwood, Pa., experimental station of the Pennsylvania Water and Power Co. The machine was intended for determining the effect of small variations in the design of the water wheel and water passages. Hence, extremely fine sensitivity was required for measuring slight changes in efficiency.

The dynamometer was constructed by setting a standard horizontal unit up on end, Fig. 3. The usual pivot bearings, which carried the entire unit and permitted it to oscillate freely so as to measure the absorbed torque, originally were ball bearings of a type not suited to carry the weight of the whole machine, about 9000 pounds, as a thrust load. The lower radial pivot bearing was omitted and in its place inserted a standard Gurney angular-contact type bearing, 5.113 inside diameter, to serve both for carrying the large thrust load and locating the frame radially.

Sensitivity Proved Insufficient

Immediately after the unit was installed its sensitivity was found to be insufficient. This was indicated first by the fact that points intended to be on a smooth curve were spread over a considerable band. Bearing friction was blamed and an attempt made to measure the error. Zero readings were taken with the dynamometer rotating without load, first in one direction and then in the other. The differential was about 6 pounds total at 21-inch radius, or 63 inch-pounds for one direction. This amounted to 1.2 per cent of the maximum scale reading of 500 pounds.

Checking up with the bearing manufacturer indicated that about 60 inch-pounds frictional drag was to be expected under the given load for this particular bearing or any other similar bearing. The problem was then to reduce thrust bearing friction or eliminate it, since brush resistance or windage losses apparently were already small.

A few tests showed that the bearing friction could be reduced by minimizing the size of the contact area between the ball and the race. Various parts of the contact surface tend to travel at slightly different speeds, thus producing an internal friction that varies naturally with the size of the contact area.

Flatter race curvatures with less intimate contact between ball and race reduce the area and the friction: For example, the usual ball thrust bearing, having rather flat race curvatures, will show a lower friction, particularly at light loads and low speeds. Note, however, that the capacity per ball falls rapidly as the race curvature is flattened.

Friction Less at Low Loads

The tests also indicated a reduced friction at low loads. Under heavy loads the size of the contact area between ball and race increases materially, and the friction with it. This change was much more noticeable in the thrust type ball bearings.

At the conclusion of the foregoing tests a special Gurney bearing was made with flatter curvatures and maximum possible number of balls. A bearing with the same bore and lesser outside diameter permitted the use of a much larger

(*Concluded on Page* 64)

New Books Reflect Progress

Dynamics, Photoelectricity, and Design Details Are Covered in New Volumes

Dynamics of Engine and Shaft, *by Ralph E. Root; published by John Wiley & Sons Inc., New York; available through* MACHINE DESIGN *for* $3.00 *plus* 15 *cents postage.*

Prepared primarily as a text book, the material presented in this volume was compiled in such a manner as to be intelligible to the reader who may not have a full working knowledge of the field which the volume covers. Prof. Root has introduced methods for evaluating the forces in a reciprocating engine, to trace their effects in turning moment on the shaft and in bearing pressures, and by emphasis on the periodic character of forces, to disclose their significance.

Treatment of torsional and transverse vibrations of elastic systems and a discussion of critical speeds are included. The first seven chapters deal with balance, turning moment and bearing pressures, while the concluding three cover vibrations.

□ □ □

Photoelectric Phenomena, *by Arthur L. Hughes and Lee A. DuBridge; published by McGraw-Hill Book Co. Inc., New York; available through* MACHINE DESIGN *for* $5.00 *plus* 15 *cents postage.*

In a critical survey of the broad field of photoelectricity Messers. Hughes and DuBridge present a thorough discussion of the three major branches: Surface photoelectric effects, volume photoelectric effects and photovoltaic effects. Fundamental laws and principles of each are summarized fully, supplemented by an explanation of their experimental bases, theoretical significance and practical application.

Special features include a comprehensive review of recent developments in photoelectric effect in metals, a detailed outline of modern experimental methods employed in research and measurements, and a discussion of the design, construction and characteristics of modern alkali-metal photoelectric cells. With the rapid advance in the application of the "electric eye" in design of machinery this book has a definite place in the engineer's library. It is timely in appearance and should prove invaluable as a reference work and guide.

The text is profusely illustrated with diagrams and curves and is interspersed with tables of important and useful data. It is modern in viewpoint throughout.

□ □ □

Business Machines, *by Perley Morse; published by Longmans, Green & Co., New York, and available through* MACHINE DESIGN *for* $3.75 *plus* 15 *cents postage.*

Indispensability of the business machine in the everyday transactions of commerce, finance and industry is established and engineers are being called upon to develop even further these labor-saving devices. For the technician engaged in this line of endeavor, the new volume entitled *Business Machines* will provide information that will serve to strengthen his background.

While the author is not an engineer, he has come into contact with practically all types of this class of equipment through his long experience as a certified public accountant. Because the book is a history of the development of the business machine it warrants consideration by the engineer. Circumstances surrounding the conception of various types of units are described, even to the point of difficulties which had to be overccme in design.

□ □ □

American Machinists' Handbook, *by Fred H. Colvin and Frank A. Stanley; published by McGraw-Hill Book Co., New York, and available through* MACHINE DESIGN *for* $4 *plus* 15 *cents postage.*

Data in the new fifth edition of this handbook has been fully revised and supplemented to provide a complete and concise reference for those engaged in mechanical work. In the five years since it last was brought up to date many changes have come about in shop practice, and the editors in this fifth edition have carefully studied these developments, compiling the new data and tabulating the practical suggestions of handbook users for inclusion.

Augmenting the information directed to machinists, the volume incorporates such information as data on screw threads, horespower, belts and shafting, measuring and fitting, brazing, soldering and welding, bolts, nuts, screws, etc.

Simplifying Parts Production by Die Casting

By Louis H. Morin

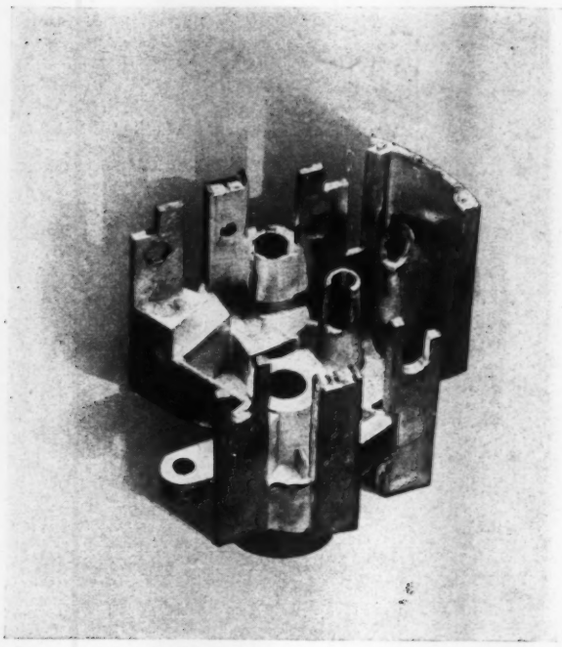


Fig. 1—Extreme accuracy and uniformity is required in this complicated main frame

DIE CASTING is well known for its ability to eliminate machining operations, yet there are other advantages in this process that are of equal value to the designer. Mr. Morin, chief engineer, Doehler Die Casting Co., outlines some of these qualities in the accompanying article based on a paper presented at the Mechanical Engineers' recent meeting at Buffalo.

FUNDAMENTAL factors of quality in die castings include strength, accuracy, and uniformity. Strength is obtained by the correct designing of the part, by choice of the proper alloy and use of only the best raw materials, by alloying under the strict supervision of chemists and metallurgists, by protecting against segregation in the process of casting, by producing a casting that is closely grained, and by eliminating casting defects. All these points must be controlled carefully for strength in a casting.

Accuracy is assured by the proper calculation of shrinkages, by the accurate construction of the die, by temperature control of the die as well as of the alloy, and by a system of continuous checking by gages or templets for the detection of inaccuracies.

Uniform castings are produced by absolute uniformity of the alloys, by temperature control, by maintaining uniform conditions during the casting process, by weighing each casting for the detection of any variation, and by extreme care in the process of cleaning. As uniformity makes for interchangeability of parts, the points enumerated must be adhered to rigidly.

A fundamental advantage of using die castings instead of machined parts is in eliminating machining operations. This holds true irrespective of the metal or alloy cast. Besides saving machining operations employment of die castings effects other savings and also opens new fields to the designer. The following examples are taken from the author's experience, and have been modified from the ac-

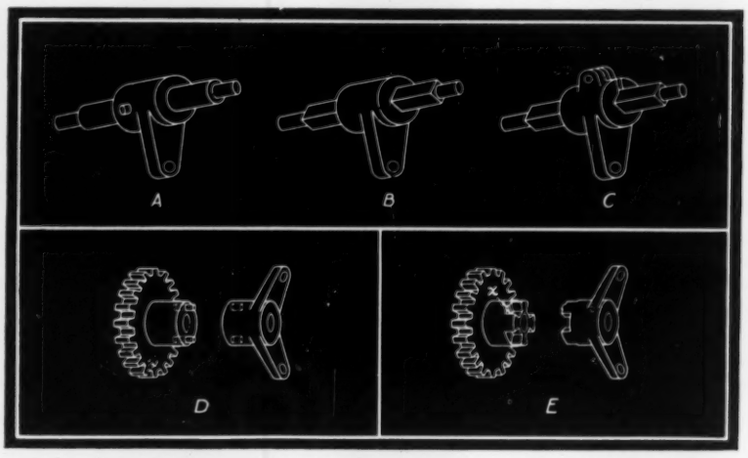


Fig. 2—Odd shaped holes or pins are as easily incorporated in die castings as round ones and often prove advantageous

tual examples to illustrate composite or general cases.

Fig. 2*A* shows a common and accepted method of mounting a lever to a shaft. The lever originally was held on the shaft by a taper pin and represents a distinct economy in comparison with the method shown in Fig. 2*B*. It costs no more to cast a square hole than a round one and the method shown at *B* serves a greater advantage at no greater cost. This fact may lead designers to consider the advantage of odd-shaped holes by the use of die castings. A clamp-hub method of fastening such as shown in Fig. 2*C* often is desirable, but is not used because it is considered comparatively expensive. As a die casting, however, this construction adds little to the cost as compared with the methods shown in Figs. 2*A* and *B*.

Correct Assembly Assured

Fig. 2*D* shows a proposed method of joining the hub of the gear to the hub of the double lever. End drive pins were to be driven into the hub of the gear and mating holes drilled in the lever to meet them and to act as a driving connection. For a machined casting the method as shown in Fig. 2*D* would be cheaper than that shown in Fig. 2*E*. As a matter of fact, *E* is cheaper than *D*

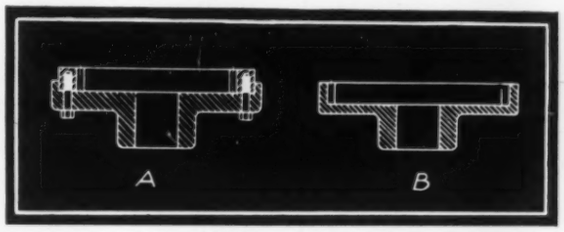


Fig. 3—Difficult machining required in cutting internal teeth can be eliminated by casting the teeth straight up against the shoulder

to produce as a die casting and is admittedly a far better piece of construction. The additional key at *x*, Fig. 2*E*, insures assembly only one way.

Machine construction frequently calls for the riveting of a part to a die casting. In a number of cases riveting studs can be cast directly into the piece at practically no extra cost and a final saving effected. Besides this, a head might not harmonize with the design of a finished surface, and by die casting the rivet in one piece with the casting the head does not show.

Internal gears are often more desirable than spur gears but they are used less frequently due to the prevailing impression in machine-cut gear practice that internal gears cost more to cut and mount than ordinary spur gears of the same size. While there is a wide differential under the usual machining methods this is not true when the gears are die cast. In Fig. 3*A* is shown the usual construction of an internal gear with its mounting by fastening the internal gear to the hub by bolts or rivets. This calls for considerable machining and is one deterring factor in a designer's mind that discourages its use.

The same problem viewed from a die casting standpoint is illustrated in Fig. 3*B*. When cast as one part the cost will be less than the built-up unit shown in Fig. 3*A* due to the saving of machining labor. Of particular interest is the fact that the teeth are cast straight up against the shoulder insuring a stronger tooth construction. A smooth exterior also is obtained.

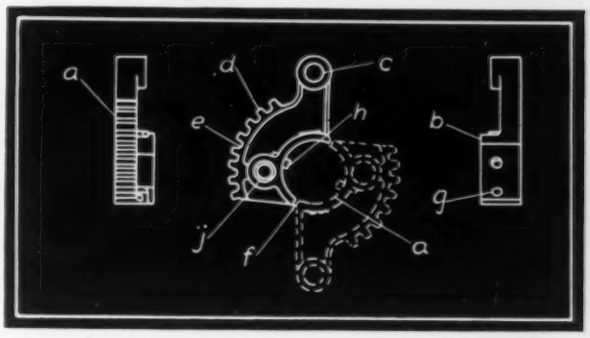


Fig. 4—Cost of die casting this drive is about one-half of the cost for machining an ordinary cast unit

The following example shows an actual comparative cost analysis between die castings and machined castings. The cost analysis for the machined casting was submitted by a reputable machine shop, and the die casting cost analysis is taken from an actual example. The cost analysis of the drive segment, Fig. 4 for 1000 machined castings including all patterns, tools and material is

	Rate	Per piece
Pattern	$10.00	$0.01
Material (weight of casting 1 lb.)	0.07 lb	0.07
a—Operation: Potter & Johnson machine, finish face and bore hole 4 min.	1.30 hr	0.045
b—Operation: Grind hub, 1 min.	3.00 hr	0.025
c—Operation: Drilling large holes 4 min.	1.30 hr	0.045
Drilling Fixtures	25.00	0.025
d—Operation: Mill radius, 3 min.	1.50 hr	0.04
Milling fixtures	20.00	0.02
e—Operation: Cutting teeth, 6 min.	1.30 hr	0.065
Mandrel for cutting teeth	25.00	0.025
f—Operation: Splitting, 2 min.	1.50 hr	0.025
g—Operation: Drilling large holes 3 min.	1.30 hr	0.07
h—Operation: Make and assemble pin, 1 min.	1.30 hr	0.02
j—Operation: Bushing, 1 min.	1.30 hr	0.02
Total cost for one drive segment machined castings		$0.505

Note: The cost of bushing is eliminated because this part is used in both analyses.

As a die casting the drive segment and an operating cam were made in the same die. The cost analysis of the drive segment for 1000 die cast-

Casting Limits of Typical Die Casting Alloys

	Tin	Lead	Zinc	Alum.	Copper
Max. weight of casting, lb.	10	15	24	10	3
Min. wall thickness, large casting, in.	1/16	1/16	1/16	0.085	0.125
Min. wall thickness, small casting, in.	1/32*	1/32	0.035	0.050	0.050
Variation from drawing dimensions per inch of diameter or length, in.	0.001*	0.001*	0.001*	0.002*	0.003*
Cast threads, min. no. per in., external	32	32	24	20	10
Cast threads, min. no. per in., internal	32**	32**	24**	none	none
Cast holes, min. diameter, in.	0.031*	0.031	0.031	3/32	3/16
Draft per inch of length or meter of cores, in.	none	none	0.003	0.015	0.020
Draft per inch of length or diameter of side walls, in.	0.0005	0.0005	0.005	0.010	0.020

*Depends on conditions. **Where cheaper than tapping.

ings, including die and tools, is given in the following tabulation:

Item	Per Piece
Die and tools ($220.00)	$0.22
Cost of casting	0.12
Total cost of one die casting	$0.34

The comparison per casting is

Machined Casting	Die Casting	Saving
$0.505	$0.34	$0.165

On a reorder the comparison per casting becomes

Machined Casting	Die Casting	Saving
$0.425	$0.12	$0.305

The cost of the die being charged to the first order accounts for the greater saving shown on consequent orders. It is apparent that it would be economical to make these particular castings

Fig. 5—Lugs, ribs and holes are permissible in design as illustrated by this gear case, about 14 inches in overall length

in a quantity as small as 500 and still show a saving, plus the fact that the dies always would be available for future orders with increased savings.

Aside from a mechanical advantage other important factors that die castings offer are appearance, style, and designs of unlimited quantity. An example of this is indicated in Fig. 6, at the left, which shows a common knob. Knob *p* is made of two screw machine pieces securely fastened together; the rod *k* is driven into the stem *m* and the whole piece chrome plated. It is obvious that strictly conventional lines were employed in making this piece, and considerable "parental" influence was transmitted in specifying the piece as a die casting because from a standpoint of appearance the exact shape of the piece as originally made was followed.

Certain milling operations as dicated at *n* proved this piece to be more economical as a die casting but the factor overlooked by the manufacturer when ordering the piece as a casting was the improved appearance that could be obtained as indicated in the redesigned knob *v*. The new design has the

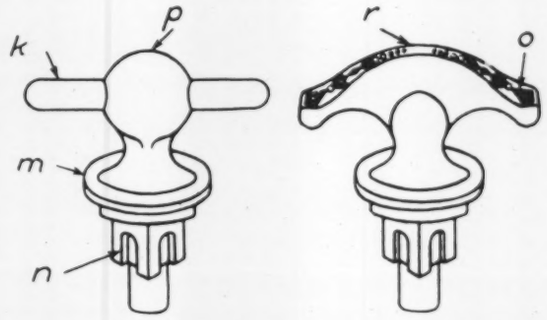


Fig. 6—Detailed decoration can be added to parts without minimizing their utility value

same utility value but it makes a great difference in the appearance of the unit to which it is attached. Notice the engraving on the face of the new handle as shown at *o*.

Details Should Be Perfect

In connection with this form of fine detail a prominent artist expressed an interesting opinion. Asked why he had incorporated minute detail in an automobile radiator cap that could hardly be seen a yard away, he replied that his object was psychological. Upon close inspection the fine engraving and ornamentation would register in the prospective buyer's mind an impression of thoroughness and attention to detail which in turn would reflect favorably upon the product. Fine engraving and intricate detail can be incorporated in die casting and the only extra cost involved in the die, while the finished part is greatly improved.

Die castings should be designed to take full advantage of saving every possible machining operation. They should be made to render their full utility value, and the artistic or appearance angle should not be overlooked.

Are Management's Criticisms of Engineers Fully Justified?

By John Stedfast

"Engineering department often is censured due to practice of 'passing the buck'"

IN EARLIER issues of MACHINE DESIGN opinions of management and of other department heads were given regarding the work of the engineering department. The following is written in answer to some of the comments contained in the articles in the hope that managers who read it may be able more thoroughly to understand the viewpoint of the engineer.

The engineering department has relations with the sales, manufacturing, inspection, service, purchasing and cost departments, and with the management. When the management is intelligent and progressive no difficulties arise between the several departments that cannot be settled quickly and amicably, but when the management is inclined to be dictatorial or lacks a grasp of the proper relations of the different departments there is bound to be difficulty.

It goes without saying that there must be close co-operation between all departments if each is to function at its best. If the product has to be engineered the salesmen cannot be mere peddlers, but must be engineers who have sufficient acquaintance with the engineering department, the shop and the service department to have an adequate background upon which they can base their sales work. In like manner, if many different kinds of material or parts must be purchased, the purchasing department must be able at least to speak the same language as the engineering, manufacturing and inspection departments. The engineering department must be familiar with the troubles encountered by the service department and also must understand thoroughly the plans and difficulties of the sales staff. Engineers frequently should be invited to assist salesmen in their work in order that they may obtain complete knowledge of the desires and prejudices of customers.

All of these facts should be appreciated by the several departments concerned. Without this there will be no co-operation. The principal function of the management is to increase the spheres of activity of the several departments and to secure the utmost degree of co-ordination.

"The management" is an elastic term. In gen-

OPEN publication of charges released by both engineering departments and managers has done a great deal toward creating better mutual understanding. The author, who has had twenty years experience as an engineer during part of which time he has been chief engineer, presents the practical viewpoint so often submerged.

eral, it means that man or group of men who are in supreme authority in an industrial enterprise. Hereafter the term "manager" will be used as meaning the executive officer who represents the owners and directors and who has the authority requisite to make final decisions on all matters, subject only to the approval of the directors.

The two greatest evils which usually confront the manager are "shop politics" and "buck passing."

Petty Jealousies Ruin Co-operation

Shop politics is one of the curses of modern industry. It is the striving of executives to secure undeserved pay, prestige or power, to magnify their work unduly, to find places for their favorites or to undermine the positions of their fellow workers. In general, such conditions naturally arise within each separate department, but between the several departments they have little effect unless the manager is weak. If the chief engineer can keep his department free from shop politics he will have little trouble from this source.

However, buck passing may make him trouble of much the same kind. The sales department falls short of its quota and for an alibi claims that improved designs would permit them to do much better; or perhaps they pass the buck to the shop and claim that the manufacturing costs are so great that they cannot meet competition and sell at a profit. Then the shop passes the buck and claims that the design cannot be manufactured efficiently. In every case the matter should be settled not by squabbles between the several departments but by wise and thoughtful action on the part of the manager.

To the manager who is not acquainted with the evils of shop politics and buck passing, or who fails to recognize the symptoms when a case appears, the engineering department often may seem to be at fault. It has been my experience that about fifty per cent of the engineer's troubles which arise outside of his department are due to the two causes mentioned. In many cases the manager fails to see the true reason for the difficulty and accordingly blames the engineer for unsatisfactory or inefficient work. Because of its peculiar place in the organization the engineering department cannot pass the buck to anyone else and cannot create much trouble by underhanded politics. Consequently, unless the manager is wise and open-minded, the engineering department suffers unduly from political activities and buck passing by other departments.

It frequently is alleged against engineers that they are not "human." When a salesman makes this assertion, he means that the engineer does not capitalize his personality for the purpose of conducting his work. Many engineers have a negative personality, while others are pleasant or even magnetic. However, engineering is done with a slide rule and T-square rather than with showmanship. Accordingly the engineer in his relations with other departments and the customer is apt to be a serious minded person who delivers his opinions without undue warmth and without regard to anything except the practical facts as he sees and interprets them.

SHOP politics is one of the curses of modern industry. It includes the striving of executives to secure undeserved pay, prestige or power, to magnify their work unduly, to find places for their favorites or to undermine the position of their fellow workers.

There is a second relationship which makes the engineer, in the opinion of many people, "not human." He does not concern himself primarily with people. He considers materials, movements and forces. He deals with facts, not with emotions, and the minute that he ceases to deal with facts and allows his emotions or desires to influence his judgment he loses all value as an engineer.

The engineer has no troubles which come from other departments except as they come through the management. No other department can dictate to him what his work shall be. Automatically he dictates to the manufacturing and purchasing departments, and he may cause them a great deal of trouble, but no one except the manager can tell him what he must do.

Unless the engineer is incompetent his troubles usually are due to faults of the management, for it is beyond question that it is easier to design,

"If engineer allows his emotions to influence him he loses all value as an engineer"

make and sell goods than it is to manage an industrial organization. Management, however, often is done by inspiration. The manager "has a hunch" that a certain product will go over in a big way, and then it becomes the duty of the engineers to design it, of the shop to make it and of the salesmen to sell it. If the manager is satisfied with the design and the product fails to sell, the sales department is the goat. If the management is not satisfied with the design because the idea is impractical or because it may be impossible to reconcile conflicting technical demands, the engineer is the goat.

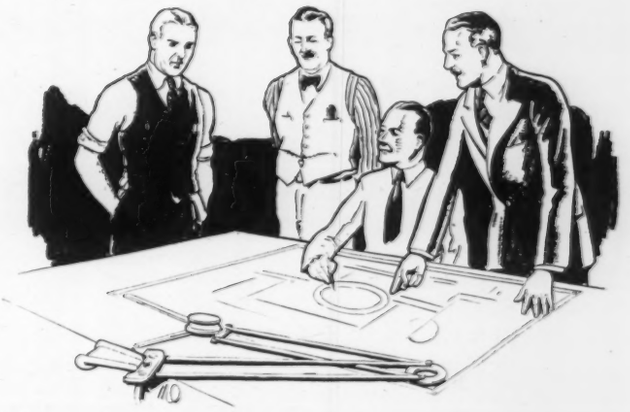
The engineer frequently is called upon to attempt the impossible. Usually this takes the form of being asked to produce a design superior in quality, material and workmanship to competing designs which will sell for a lower price.

THE principal defect of the engineer is that he is not a good salesman within his own company. Furthermore, when he goes outside to help the sales department there is only one kind of customer with whom he is successful and that is the customer who buys with enlightened self-interest in mind.

Many an engineer has been requested by the management to design some particular improvement when he knows in advance that the improvement will cost so much that it cannot be sold. The management, seeing only the desirability of the improvement, is inclined to discount his statements and recommendations and tell him to go ahead with the design. After much labor the design is produced. It is an excellent design mechanically, yet it is not a success. It costs too much or is in advance of its time and is not required in such quantities that it can be manufactured by special processes at a low price. Is the engineer or the management at fault?

Outlines Design Procedure

A second difficulty which the engineer encounters in his relations with the management is the demand that he produce a design in insufficient time. Common sense dictates that a number of designs be prepared and that they each be considered carefully with reference to sales appeal, the real needs of the customer (which often is a radically different matter from sales appeal), cost of manufacturing, service difculties and patent infringements. After such preliminary work is done a period of discussion should ensue followed by a period in which the details are refined. When the task is undertaken in this way a successful design is bound to be



"Foremen drop into the engineering department and obtain many helpful suggestions"

produced. However, directors and managers are frequently impatient, demanding that the work be done immediately. As a result many mistakes are made both in design and construction and the final product either is pronounced unsatisfactory, or assumes satisfactory form weeks or months after the expected time.

Managerial indecision often hampers engineers. An engineer usually knows whether a design is satisfactory or unsatisfactory. If it is unsatisfactory he knows whether it should be rejected entirely or altered and improved. When he has arrived at the point where he is satisfied with his design and has presented it to the management, he should be able to expect that a decision will be forthcoming upon which he can proceed. This often is not available.

Experimental Investigation Needed

The attitude of many managers, especially non-technical managers without an adequate engineering background, toward the technical knowledge of the engineer is frequently amusing, but more often irritating. The engineer is expected to know a great many things which nobody knows, and which nobody can know without a great deal of experimental investigation. The engineer's opinion is taken without any question upon matters of which the management is totally ignorant and knows that it is totally ignorant. The engineer may be dubious himself about the soundness of his information and may point out that there are two schools of engineering thought with regard to the matter, and that at best he is giving an opinion, but his opinion is received with respect.

On the other hand the manager may have definite opinions of his own which have no basis in fact, and may dispute with the engineer about such elementary matters as the strength of a wire rope or the stiffness of a beam. A manager who has never run a machine in his life will settle arbitrarily on an incorrect location of controls on the basis of appearance in spite of the

fact that the engineer knows by experience that the design he proposes is correct from the standpoint of safety and convenience.

Another difficulty which the engineer has with the management is impatience while the engineer is seeking to refine and improve a design which he has reason to believe will be satisfactory. Many managers are the reverse of timid or hesitant; they make up their minds without rhyme or reason in the tick of a watch. A piece of apparatus gives trouble in the service depart-

"The engineer is not a good salesman"

ment but no one can tell why. The engineer institutes a study to find where the difficulty lies. He gives to the work such time as he can spare from other and even more pressing matters. After two or three days the manager wants to know why the difficulty has not been remedied. Since the engineer has not yet found the cause of the trouble the manager is apt to decree an entire change in design.

Interference on the part of the manager in the detailed administration of his work is a situation that the engineer in common with other department heads frequently encounters. This interference may come because of representation from other departments or because the manager feels the need of asserting himself. Those managers are most successful who leave the detailed administration of each department to the head of that department and confine their efforts to co-ordinating the work of the departments.

Advice Is Available

The engineering department cannot make available its services to those who will not have them. I have in mind a certain small company whose shop is in the hands of a hard-headed superintendent and a group of practical foremen. Two of these foremen have discovered that the engineering department may be a great help to them, that they can drop into the office and discuss their troubles and receive practical advice about phases of their work which they do not understand. The other foremen do not avail themselves of this opportunity but prefer to work by rule of thumb. One department thus gets a full measure of service while another gets nothing.

The principal defect of the engineer is that he is not a good salesman within his own company. When he goes outside to help the sales department there is only one kind of customer with whom he is successful and that is the customer who buys with enlightened self-interest in mind. With the customer who is arrogantly ignorant, with the one who knows much that is not so or whose only thought is of price concessions the engineer is never successful. Fortunately, the type of customer who gives intelligent consideration to his own best interests is in the great majority, and with such customers an engineer of reasonably good personality is a successful salesman. Within his own company, however, the engineer does not regard himself as a salesman. He feels that it is the business of the management and of his fellow workers to listen to his suggestions and to consider them on their merits. If he says "it can't be done" when someone makes a suggestion, it is usually because he knows that it cannot be done in the manner suggested or that the proposal embodies obvious inconsistencies. The engineer is always open-minded toward changes which are sound from an engineering standpoint, but he is anything but open-minded toward changes for the mere sake of change.

Suggestions Aid Engineers

One of the best managers with whom the writer has ever come in contact was a lawyer. He frankly admitted that he knew nothing about the work of the several departments which were under his control. But he was a man of common sense, vision and tact, who was able to keep each department within its own proper sphere of activity, and at the same time to create a spirit of co-operation and helpfulness between the several departments. To the engineers he never offered engineering advice, but he offered many helpful suggestions as to the best organization of their department and its relations to other departments. He offered no criticism of their work but did invite outside engineers to offer such criticism, not to him, but to the engineers who worked under him. He sometimes, but not often, changed his policy and ordered corresponding changes in the engineering work. His whole attitude was one of helpfulness.

Faults of management cannot, of course, always be blamed on the individual manager. He often is hampered by his board of directors, by market conditions or financial limitations. He must be jack of all trades and master of none, and he has little of precedent, theory, or formula to guide him.

Complete Redesign Required for Welded Construction

By D. L. Pellett

CONSIDERABLE attention to stress distribution and stress magnitudes is required of the welding designers since he cannot design upon experience gained from the construction of cast machines. Stress determinations in weldings often require new methods of analysis and original angles of approach.

Pebble mills are among the many machines that have been redesigned for fabrication by welding with a resultant lowering in manufacturing costs and the production of better equipment. Since these mills are typical of a large class of similar machines it seems worth while to consider the procedure that was followed in the design.

In the past it has been general practice to build pebble mills, tumbling mills and similar structures with cast heads and riveted shells. In some cases the heads were secured to the shell with the aid of an adapter ring which, in turn, was riveted to the shell and bolted to the head. This type of construction necessitated the use of large and expensive patterns and drill jigs. Fig. 3, top, shows the details of such a mill.

IN the October issue Robert E. Kinkead outlined the importance of proper stress determination in welding design and pointed out various considerations that should be taken into account in this form of construction. An actual example of redesign and analyzation of stresses for fabrication by welding in a pebble mill is given in the accompanying article. Mr. Pellett was a prize winner in the recent Lincoln contest.

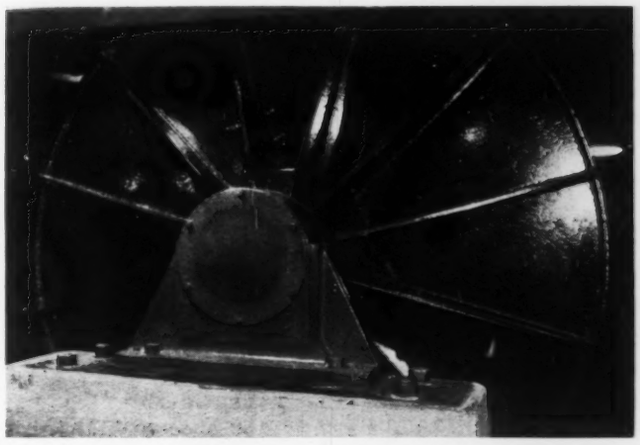


Fig. 1—Twelve radial ribs resist bending moment imposed on the head by journal reaction

Fig. 3, below, is the welded unit that replaced the old design. The outer shell is a ½-inch steel plate, rolled to shape and welded at a butt joint. The head consists of a ½-inch, circular steel plate with a steel journal casting welded to the center of the head. This design was chosen in preference to a dished end plate, with a flat strengthening diaphragm, by employment of which it might have been possible to place the weld between end plate and shell plate at a point of lower stress. Satisfactory operation of the completed units over long periods has proved the present arrangement successful.

Drive Shaft Welded in Place

The casting on the driven head is bored for the drive shaft which is welded in place. Twelve radial ribs, each ¾-inch thick, resist the bending moment imposed upon the head by the journal reaction. This mill was designed for a total dead load of 70,000 pounds and a rotational speed of 16 revolutions per minute. The load includes the weight of the drum, a lining of silica brick, a quantity of quartz pebbles and the material being processed.

Surfaces of pebble mills are subject to severe corrosion. This condition makes it advisable to

keep the working stresses in the structure as low as possible. The writer has considered the head plate as carrying only torsional loads. The bending stresses in the shell plate are quite small, yet the corrosive conditions and fabrication re-

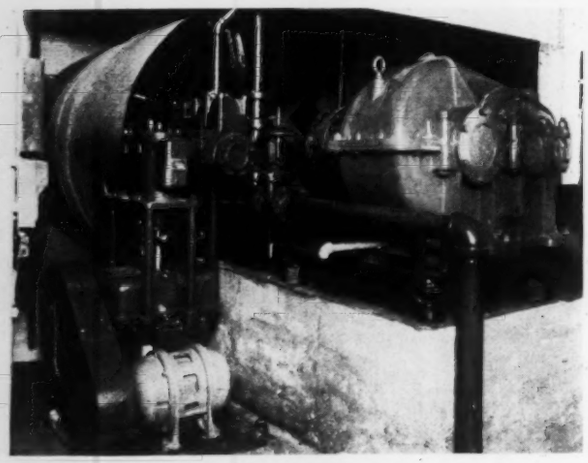


Fig. 2—Pebble mill is designed for a total dead load of 70,000 pounds and a maximum speed of 16 revolutions per minute

quirements would not permit a reduction in plate thickness.

The maximum working stress in the ribs was assumed to be 8000 pounds per square inch, this figure giving a factor of safety of four based on a fatigue limit of 32,000 for mild steel. Welds in tension, compression or bending were stressed to 5000 pounds per square inch, welds in shear were stressed to 4000 pounds.

A stress analysis of the head is complicated by the indeterminate nature of the structure. The bending forces acting at the outer ends of the twelve ribs are distributed according to some unknown relationship. This relationship cannot be determined with the static equilibrium equations of applied mechanics. In other words, the structure is statically indeterminate with twelve unknowns.

Number of Unknowns Reduced

However, it is fortunate that the head can be analyzed in a position symmetrical with the horizontal and vertical center lines of the machine. In this case the loads acting upon any four symmetrically placed ribs will be equal, thus reducing the number of unknowns from twelve to three. These three unknowns can be determined with the aid of Castigliano's theorem of "least work." This theorem states that, "the internal work done in any structure by the application of external forces will be the least possible, consistent with equilibrium." The following are the steps in the application of Castigliano's theorem.

Compute the work done in the structure by the application of external forces.

W = work stored in a beam

$$= \int \frac{M^2 dx}{2\ EI}$$

M = bending moment in a beam section x distance from the end of the beam

dx = increment of beam length

E = modulus of elasticity of the material in the beam

I = moment of inertia of a beam section x distance from the end of the beam

Perform a differentiation of work with respect to each unknown.

Set each of the derivatives from 2 equal to zero.

Solve the equations resulting from 3 for the required unknowns.

Additional terms needed for the solution of this problem are

B = load concentrated at the end of a rib

P, Q and R = total of all loads B on those ribs having the moment arms a, b and c, respectively

$$W = \int \frac{B^2 x^2 dx}{2\ EI}$$

= total work stored in any head rib

$$= B^2 \int \frac{x^2 dx}{2EI}$$

$= B^2K$, when K is an unknown constant with its value depending on the dimensions of the ribs

W_t = total energy stored in the twelve beams

$= K(P^2 + Q^2 + R^2)$

$D = 13.5 \times 35{,}000 = aP + bQ + cR = D$

= total bending moment applied to the head by the journal reaction

$$R = \frac{(D - aP - bQ)}{c} \qquad (1)$$

$$W_t = K\left[P^2 + Q^2 + \frac{(D - aP - bQ)^2}{c^2}\right] \qquad (2)$$

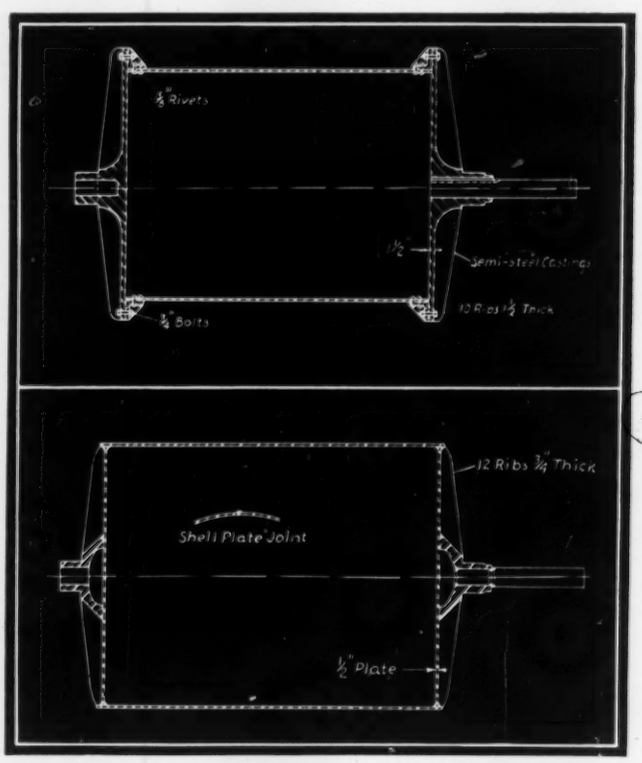


Fig. 3—(Top)—Original design necessitated large patterns. (Below)—Redesigned constructed using welding method

If equation (2) is differentiated with respect to P and the result made equal to zero, the following equation is obtained.

$$Pc^2 + abQ - Da + Pa^2 = 0 \quad \text{.....(3)}$$

If equation (2) is differentiated with respect to Q and the result made equal to zero, the result is

$$Qc^2 + abP - Db + Qb^2 = 0 \quad \text{.....(4)}$$

The following are the numerical values of a, b and c for the position of the head shown in Fig. 4.

$$a = 43.5 \text{ inches}$$
$$b = 32 \text{ inches}$$
$$c = 12 \text{ inches}$$

Equations (1), (3) and (4) were solved simultaneously after the numerical values of a, b and c were introduced. These solutions wielded the following results.

$$P = 6600 \text{ pounds}$$
$$Q = 5100 \text{ pounds}$$
$$R = 1600 \text{ pounds}$$

Each of the above values must be divided by four to obtain values of B, the concentrated load applied to the end of any given rib. If the head is rotated through an angle of 15 degrees from that shown in Fig. 4 another set of values for P, Q and R can be obtained by the method just outlined. These values, together with those values obtained from the first solution, give the following values of B for various values of Θ.

Θ, *degrees*	b, *pounds*
0	0
15	400
30	850
45	1275
60	1530
75	1660
90	1750

The length of the radius vector r in Fig. 4 is equal to a value of B at a corresponding value of Θ. It will be noted that the shape of the resulting polar curve is a circle, within the errors of slide rule computations. This fact furnishes an index to the relative distribution of the rib bending loads. Similar structures can be analyzed by an application of the shape of this curve for the determination of the maximum value of B. It is obvious that for the case being discussed the maximum value of B, 1750 pounds, is the design load for the ribs, considering them as being cantilever beams.

Theoretical Curve Must Be Modified

The actual design of the rib is a rather simple and familiar problem. Since the head plate is not considered as having strength, its only purpose in the rib design is to prevent lateral bending of the ribs. The theoretical curve obtained by designing the rib as a cantilever beam of uniform strength, must be modified at its tip in order that the rib will be wide enough to carry a weld of sufficient length to resist the shear load of 1750 pounds.

Welds connecting the rib to the head casting must be designed for strength equivalent to that of the rib base. The size of shaft weld can be obtained easily by considering the minimum weld section as a hollow shaft subjected to torsion. Welds securing head to shell plate, ribs to head plate and hub casting to head plate are of a rather arbitrary size and must be proportioned by practical considerations.

It generally is conceded that welding is an economical fabrication method. However, many designers feel that this economy is achieved with some sacrifice in the strength and rigidity of the structure. This attitude is not tenable. If proper attention is given to the stress analysis of the welds and the structural members a unit can be developed that will equal or exceed the cast structure in strength and rigidity.

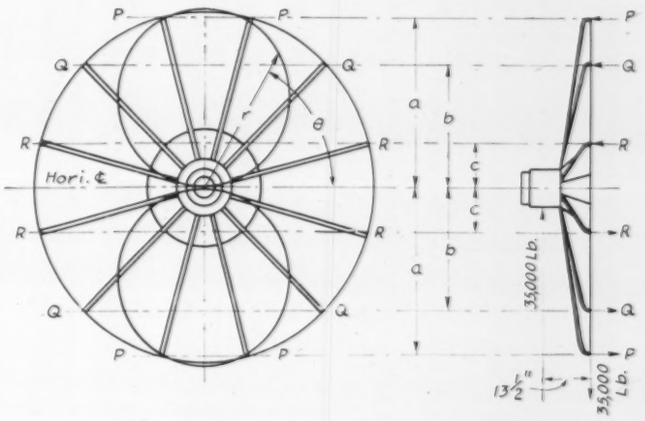


Fig. 4—Diagram used for determining stress in ribs

Speeds Action on Patent Applications

MORE rapid action by the patent office and a considerable falling off in the number of applications received have served to reduce the number of applications awaiting official action to a number smaller than at any time in the last five years, according to Commissioner Thomas E. Robertson. Between January 1 and September 30 this year 52,440 new applications were received, a reduction of 8665 from the 61,105 applications received during the same period in 1931. The increase in filing fee from $25 to $30 has no doubt had considerable influence in bringing about the reduction.

Increased appropriations by Congress, enabling the office to employ 110 additional examiners has made possible a still further reduction in patents awaiting official action. On January 1, 1932, there were 90,274 on hand, while by September 30 this had been cut to 68,105, a decrease of 22,169 or 24.5 per cent as compared with the decrease in new applications of 14.2 per cent. It is expected that the number of applications pending will be below 60,000 by January 1.

Editorial

Where Is Dividing Line between Purchase And Manufacture of Parts?

ONE of the fine points in the good management of a manufacturing establishment is to know whether to make certain parts in one's own shop or to buy them. This question is receiving more than usual attention today because many companies are finding it difficult to justify the operation of foundry, forge, stamping and other departments. In many cases they are closing down these facilities and purchasing castings, forgings, stampings, etc. in the open market.

As industry emerges from the depression, the question will arise as to whether these departmental shops shall be reopened or permanently abandoned. This is a problem of post-depression policy in which the opinion of design engineers should carry considerable weight.

In the past, departments frequently were added to plants with little consideration for their restricting influence on design. Too often, engineers have had to specify "home-made" materials or parts in order to help nurse along unprofitable departments, when it would have been far better for all concerned if the products had been purchased from outside specialists. Of course in large establishments and in smaller ones where peculiar conditions pertaining to certain parts prevail, the operation of foundry, forge or other departments may be warranted.

The important point is that the decision to make or to buy should not be reached through consideration of financial and operating factors alone. It should also take into account the interest of engineering and design, which in many establishments will be found to be the paramount issue in the question.

The Trend Toward Unitization

DESIGN for unit assembly is not new. Any properly laid out design necessarily must incorporate certain basic practices—and this is one of many that have long been employed. Yet there still is a great deal to be done in applying the principle of unit construction to the greatest advantage.

Complete interchangeability of assembled units is one of the features of unit design that up to the present has not been sufficiently considered. Such interchangeability facilitates in many cases the redesign of unit assemblies without fear of changing the entire machine layout, permits stocks of completed units to be carried and enables the same assemblies to be incorporated with ease in different models of similar machines.

Comprehensive treatment of this matter is desirable and MACHINE DESIGN therefore plans to devote considerable space in future issues to the formulation of a new theory on the subject.

Henry Maudsley

Master Designers

Henry Maudsley

EFFICIENT tools and well qualified men—no design can succeed without both. And no man contributed more of each than Henry Maudsley. His was the career of the expert mechanic who, although credited with relatively few inventions, left his impress on every mechanical contrivance and every man contacted. He devised, rearranged and simplified mechanisms and he trained men to broader conceptions of design and production and broader outlooks generally.

BORN in Woolwich, England, in 1771, Maudsley began work in the arsenal at the age of twelve and soon gained recognition for his industry and ingenuity. When Joseph Bramah required a mechanic to build his extremely intricate locks, Maudsley was recommended. Despite his youth—he was only 18—he succeeded, designing tools and processes of unusual merit. It was while he was with Bramah that he made his important contributions to lathe design and invented the self-tightening collar for hydraulic presses.

MAUDSLEY made the lathe an instrument of precision. He devised the slide rest, constructed the first unit made entirely of iron, and developed a technique that made it possible to cut accurate lead screws of some length. This last innovation brought about the abandonment of the traversing mandrel in favor of the more flexible principle of the traversing tool. Maudsley also invented a machine for punching boiler plate and the direct-acting motion for steam engines. He contrived and built forty-four entirely new machines for making blocks used in raising sails.

MANY men who later were to make their own contributions to design were trained by this pioneer in mechanical improvement, including James Nasmyth, Sir Joseph Whitworth and Joseph Clement. Maudsley was extremely interested in the progress and capabilities of his workmen and overlooked no opportunity for instructing, encouraging or advising them. The developments made by his pupils place his efforts in their behalf on a par with his important mechanical achievements. He died in 1831 from a cold contracted while visiting a friend in Germany.

PROFESSIONAL VIEWPOINTS

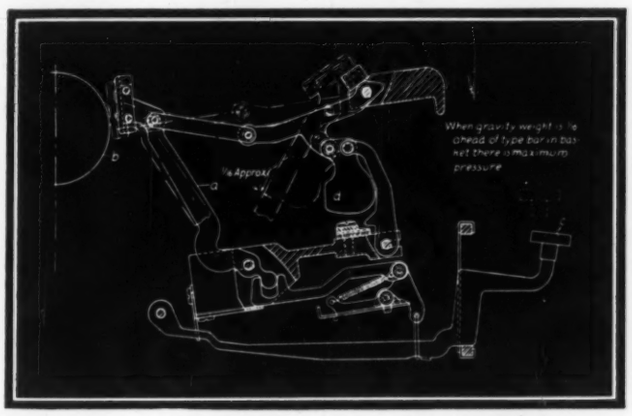
Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Solving the Noise Problem

To the Editor:

WITHIN the past few months there has been developed another type of noiseless typewriter action which might prove of interest in connection with your recent series on noise in machines and its elimination. This new principle, which in some respects is the reverse of that used in the noiseless standard or office machine,



Weight acts as a retarder in portable typewriter action to cushion the blow and reduce noise

is utilized on portable models. The standard noiseless typewriter action is not adaptable to the portable machine because of its reduced size and weight.

In the standard models the key lever merely starts a weight in motion. The action of this weight brings the type bar against the platen roll with such exacting pressure that it is possible to use a steel platen roll and secure excellent printing results without noise. In the new action, the weight acts as a retarder instead of furnishing the impetus which provides pressure printing. The lever, *a* in the accompanying illustration, is driven to the platen roll *b* by pressure of the typewriter key *c*, but the weight *d* prevents the type bar from snapping against the platen roll. This has a tendency to slow the bar slightly, but it is gaged so accurately that writing speed is not sacrificed. The weight adjustment permits the key action to carry through with just the pressure needed for noiseless writing.

While noise has been a growing menace since early in the present century, only in recent years has its study and elimination become a definite science. Undoubtedly it is partly coincidence and partly foresight that development of the noiseless typewriter progressed during this period in which noise has increased rapidly. Now, at the time when the importance of noise elimination is fully recognized, the machine which definitely removes din from the business office has reached its peak of efficiency.

—ROSS H. COLLER,
Buffalo.

Perfect Patent Agreements!

To the Editor:

IT SEEMS to me that all employers of technical and engineering talent would save themselves much grief and annoyance if they were to have carefully prepared invention agreements. I know of several instances and I suppose most readers of MACHINE DESIGN have heard of other cases wherein firms have spent much time and money in patent interference cases.

Some companies require new technical men to sign a pre-employment contract in which is stated the company's right to the use of such new processes or inventions as the man may develop. Other companies have contracts with the employes of their development departments which bind the employes to turn over to the company all inventions which they might develop while in their employ. There is a sliding scale of remuneration for effective original work.

Fully half of the total number of employers have no agreement whatever. To say that they are inviting trouble is to put it mildly. Their entire business future might be predicated upon the question as to whether or not they had some such agreement.

Employer-employe agreements are many and

varied and it is advisable to have a patent attorney prepare one adapted to the business in question.

It is equally important for the engineer and chemist to see that his interests are protected. Verbal agreements are difficult to prove. A written agreement is the legal safeguard of both employer and employe.

—J. M. MURPHY,
Lakewood, O.

More and Better Machines

To the Editor:

IN CONNECTION with your interesting editorial on "More and Better Machines" in the October issue, I wish to call your attention to a machine which reduces costs, increases employment, improves working conditions for employes and produces a better product. Such machinery is of the type that is required today to help improve employment conditions. This machine is a new process for dry-scouring strip, sheet, rod and bar to remove the scale and oxide in place of the old acid pickling process.

In planning a recent installation for a production of about 300 tons per 24 hour working day and using actual performance data, the labor requirements were increased 50 per cent over previous figures, and total cost was reduced.

Installation of machines does not always cause increased unemployment, but in cases where automatic machinery does reduce employment the employe is entitled to a readjustment whereby a higher rate will be paid on account of reduced hours. I believe that one of the greatest mistakes made in installation of new machinery and equipment is to expect a new machine to pay for itself from the reduced labor cost in less time than a safe estimate on the number of useful years of life of the machine.

—CHARLES A. DREISBACH,
New Haven, Conn.

Quiet Design Office Noises!

To the Editor:

TWO of the most disturbing elements which tend to impair the engineer's thinking capacity are loud discussions and whistling. In clarifying what the company officials expect of the engineer, it might be well to study the means of eliminating disagreeable factors of this kind in order to give the engineer every possible opportunity to meet the expectations of the management.

When we enter a library reference room we find that general quiet prevails. Talking in an undertone only is permitted. It is taken for granted that noises distract attention. Why then should not the engineering office be conducted on the same principles? Thinking out and solving problems is the engineer's task, why make that task more difficult?

A design office should not be used as a conference room between the chief engineer and other company officials. Often disagreements arise, causing voices to be raised. To the engineer, this creates a contest of wits and he unwittingly awaits the outcome. Naturally he cannot do two things at once, so he takes the line of least resistance, getting amusement from the argument. After all he is human.

The second of these petty annoyances should be altogether taboo. The habitual whistler, while apparently spreading good cheer, unconsciously turns over in his mind the words of the tune. He also starts the other tune-minded fellow who enters the serenade with tenor or bass. The result invariably is the "raspberry" whistle from the rest of the force!

—F. A. FIRNHABER,
Waynesboro, Pa.

Rejuvenating the Veteran Designer

To the Editor:

WHEN sales drop and the shop is silent three days a week, an unprecedented effort must be made to perfect the product of the company and the ideas of yesterday must give way for those that are up-to-the-minute. In times like this the veteran designer is something of a problem. He has, or thinks he has, tried all the wrong ways to do a thing, and likewise thinks he knows all the right ways. Consequently he too often is satisfied to mark time.

Personally I think there is great hope for the veteran and I believe he can be revitalized and rejuvenated with tact and suggestion. To tell him that he and his ways are old only drives him deeper into his rut where he endeavors to persuade himself and others that there is nothing to beat the good old ways; but put in his way up-to-date books and technical publications and tell him you know how he appreciates such literature and he will become interested. Before long he will be "suggesting" to himself that he is mentally wide awake and delighting in new original ideas.

—ALFRED C. LAYZELL,
London, England.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

AN AMERICAN standard value to be used by industry in converting inches to millimeters was recommended by a conference held under the auspices of the American Standards association on October 21, following a request of the Ford Motor Co. The conference unanimously recommended the conversion factor of one inch equals 25.4 millimeters to become the American standard value, replacing the official ratio 25.40005 and the rounded value 25.4001 given in certain handbooks and tables.

Official British ratio is 25.399978. Thus their value is about one part in a million below, and the American value about two parts in a million above 25.4. British industry, through the British Standards institution, accepted the value 25.4 for industrial use in 1930. Adoption of the conversion ratio 25.4 by American industry will secure world-wide uniformity in conversion practice.

* * *

Discusses Six-Wheel Truck Development

ENGINEERING progress in the development of six-wheel trucks is a topic of more than ordinary interest at the present time. The subject was discussed thoroughly by Austin M. Wolf at the recent transportation meeting of the Society of Automotive Engineers at Toronto, Ont. He referred to road impact tests as evidence of the six-wheel truck's ability to carry heavy loads with less destructive effect to the roads and its own mechanism than would occur with the four-wheel unit.

Mr. Wolf declared that engine capacities must measure up to the work. The trend is toward larger engines and the increased fuel consumption soon will outweigh the possible economy of a smaller engine. An engine of relatively slow speed with high torque output is desirable.

* * *

Packaging Manufacturers Discuss Problems

PACKAGING machinery manufacturers have recognized the need for an organization as indicated by the announcement that a meeting of this group was held Oct. 6 and 7 at Buckwood Inn, Shawnee-on-the-Delaware. The major purpose of this initial gathering was to provide for a better acquaintanceship within the industry and for a discussion of some of the problems.

H. H. Leonard, vice president, Consolidated Packaging Machinery Corp., was elected chairman of a committee to arrange for a meeting during the American Management association's packaging conference and exposition in New York in March, and for another meeting in the autumn of 1933.

* * *

Supreme Court Rules Radio Patents Invalid

VALUABLE patents on devices enabling radio receiving sets to operate on ordinary alternating current were ruled invalid by the United States supreme court recently, according to the United Press. Dubilier Condenser Corp., holder of the patents, charged that the Radio Corp. of America was infringing them. The federal circuit court at Philadelphia held the patents invalid and the supreme court affirmed this decision by denying a review.

In another important patent decision, the court refused to review the unsuccessful suit of Glenn H. Martin, well-known aviation engineer, to collect royalties from the government on a lubricating system which, he claimed, was used on Liberty airplane motors during the World war. A lower court has ruled Curtiss' patents invalid also.

* * *

New Dictionary Lists Electrical Terms

CONFUSION resulting from conflicting electrical definitions used in different engineering textbooks and by different technologists and teachers of engineering soon will be eliminated. A proposed dictionary of electrical engineering terms, representing the results of over three years' work by a committee of 120 scientists and engineers under the chairmanship of Dr. A. E. Kennelly of Harvard university, has been published for review and criticism prior to its submittal to the American Standards association for adoption as an American standard.

The report, prepared under the direction of the American Institute of Electrical Engineers, is a document of 208 pages listing over 3400 interpretations ranging from the fundamental definitions on which the science of electricity is

(*Concluded on Page* 51)

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

OUTSTANDING both as an educator in the engineering field and as a designer, Roy A. Seaton, dean of division of engineering, Kansas State college, Manhattan, Kans., has been made president of Society for the Promotion of Engineering Education. This honor was bestowed upon him at the recent annual meeting of the organization. He is a graduate of the engineering course at Kansas State college and of Massachusetts Institute of Technology.

In 1911-12 he put aside teaching to engage in the design of steam turbines, centrifugal air compressors and other high speed machinery. During the World war, February to November, 1918, Dean Seaton served as captain in the office of the chief of ordnance at Washington and worked on the development of artillery ammunition. He holds the distinction of having made the official computation for the war department on the ballistics of long range shells fired by the Germans on Paris as well as having determined the type of gun firing such shells and the use the United States might be able to make of such a gun.

After the war he became a member of the faculty of the department of machine design at Kansas State college, and in 1920 was made dean of the division of engineering and director of the engineering experiment station. Dean Seaton has been secretary and later chairman of the engineering section of Land Grant colleges and is a member of the American Society of Mechanical Engineers, Phi Kappa Phi, Sigma Xi, Sigma Tau, and fellow of the American Association for the Advancement of Science.

METALS, their properties and the problems involved in selection, being of uppermost importance in the minds of designers of machinery it is natural that the activities of American Society for Steel Treating should be of interest to the machine design profession. In the society's new president, W. B. Coleman, the machinery industry sees a capable executive.

As head of W. B. Coleman & Co., Philadelphia, he supervises consulting work in metallurgical engineering covering various phases of open hearth and electric steel manufacture; processing of steel and heat treatment, and laboratories for chemical analysis and metallurgical and physical testing. Mr. Coleman is a graduate of Hill high school, Pottstown, Pa., and the University of Pennsylvania. He was in charge of foundry and open hearth furnaces at the plant of the Midvale Steel Co., Philadelphia, following which he was appointed superintendent of the open hearth department, Coatesville, Pa., works, Midvale Steel & Ordnance Co.

Subsequently Mr. Coleman was affiliated with the Tacony Steel Co. and during the World war was civilian consultant on all gun steel manufacture to the ordnance department, Washington.

IN RESPONSIBLE charge of the extensive work on fuels, lubricants, internal combustion engine problems and automotive projects carried on by the bureau of standards, Dr. H. C. Dickinson possesses a unique background. He is the 1933 presidential nominee of the Society of Automotive Engineers in which he has held membership since 1918. In 1921 when the research department of the society was instituted, he became its manager and continued in that capacity for two years.

Born in Bangor, Maine, October 11, 1875, Dr. Dickinson studied at Williams college and later at Clark university, obtaining his Ph.D. degree from the latter in 1910. His association with the bureau of standards began in 1903 when he engaged in experimental laboratory work on problems of heat, thermometry, calorimetry and thermodynamics of internal combustion engines. Since 1922 he has held the position of chief of the heat and power division of the bureau.

Dr. Dickinson holds many important offices on technical committees of the government and associated organizations. In addition to having been the author of many outstanding technical articles, he holds membership in several engineering societies.

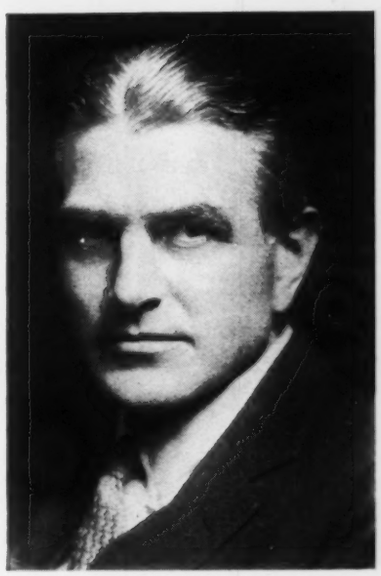
TWENTY-TWO years, his entire business career, with one company is the record of Henry S. Beal who recently was elected president of the National Machine Tool Builders' association. As general manager of the Jones &

Leaders in Design, Engineering and Research

ROY A. SEATON

W. B. COLEMAN

H. C. DICKINSON



HENRY S. BEAL
—Bachrach

Lamson Machine Co. he has had the opportunity of acquiring a keen picture of the machine tool industry and its problems.

A native of Rockford, Ill., Mr. Beal attended Dartmouth college, Hanover, N. H., for two years and studied later at the University of Berlin for one year. After he left school in 1910, he entered the employ of the Jones & Lamson company, starting in the shop and advancing steadily to assistant general manager. At the end of five years he was made general manager. That was six months ago. For six years Mr. Beal has been active in the affairs of the National Machine Tool Builders' association, having been second vice president prior to his election as head of the organization.

* * *

A. R. Petterson, formerly chief engineer of New England Wire Machinery Co., will have charge of sales and engineering work in the department recently established by Thomson-Gibb Electric Welding Co. for the manufacture of a complete line of wire mill and stranding machinery.

* * *

John Toth, formerly connected with Brown & Sharpe Mfg. Co., Providence, R. I., as design engineer, now is employed as a development engineer with Atwood Machine Co., Stonington, Conn.

* * *

George G. Thorp, President, Illinois Steel Co., has been elected to the board of trustees of Armour Institute of Technology, Chicago. Mr. Thorp is a graduate in mechanical engineering of the University of Wisconsin.

* * *

R. C. Cosgrove, manager, refrigeration division, Westinghouse Electric & Mfg. Co., has been placed in charge of the company's domestic air conditioning activities in addition to his present duties. He is a graduate of Carnegie Institute of Technology and joined the company in 1919.

* * *

Herman A. Wagner, consulting mining and metallurgical engineer, Chicago, recently was awarded the second Clausen gold medal of the American Association of Engineers for distinguished service performed in behalf of social and economic welfare work for the engineer.

* * *

Glenn E. Weist, formerly sales engineer with the Milwaukee Electric Hoist division of the Harnischfeger Co., Milwaukee, has joined the Kron Co., Bridgeport, Conn., manufacturer of automatic dial scales. Mr. Weist will be in charge of engineering. He is a graduate of Purdue university and has had a wide experience in the engineering field.

* * *

William Bardenheuer, formerly chief engineer of Brunswick-Kroeschell Co., Chicago, recently joined the production design department of Carrier Engineering Corp., Newark, N. J.

* * *

J. P. Den Hartog, since 1931 chief of the dynamic section of Westinghouse research laboratory, has been appointed assistant professor of applied mechanics at Harvard university.

* * *

S. H. Mortensen has been appointed engineer in charge of alternating current design for the Allis-Chalmers Mfg. Co., Milwaukee, to succeed the late R. B. Williamson. Mr. Mortensen was first assistant to Mr. Williamson for many years.

* * *

Nathaniel B. Wales, inventor of a number of mechanical products including the Kelvinator refrigerator, recently became associated with the G. M. Basford Co., New York. He is in charge of engineering and research in the new products development division of the company.

* * *

Clayton R. Burt, president and general manager of the Pratt and Whitney Co., Hartford, Conn., and a member of the board of directors of the National Machine Tool Builders' association, has been elected to membership on the board of directors of the American Standards association.

* * *

Frank P. McKibben, consulting engineer and president of the American Welding Society, was awarded the Samuel Wylie Miller medal at the society's Buffalo meeting recently, in recognition of his work in the development of welded steel structures. A biographical sketch of Mr. McKibben appeared in the July, 1932, issue of MACHINE DESIGN.

* * *

George H. Charls has resigned as president and treasurer of the National Association of Flat Rolled Steel Manufacturers to become assistant to Robert P. Lamont, new president of the American Iron and Steel Institute.

* * *

J. S. Tritle, vice president and general manager of the Westinghouse Electric & Mfg. Co. was elected president of the National Electrical Manufacturers' association to succeed John H. Trumbull, former governor of Connecticut, at

the recent annual meeting of the organization. A biographical sketch of Mr. Tritle appeared in the August, 1931, issue.

* * *

W. H. Phillips, vice president, Molybdenum Corp. of America, Pittsburgh, was made vice president of the American Society for Steel Treating at the recent annual meeting in Buffalo. New directors are: R. S. Archer, director of research, A. O. Smith Corp., Milwaukee, and H. G. Keshian, metallurgist, Chase Companies Inc., Waterbury, Conn.

* * *

Dr. Fredrich Sass, chief engineer, diesel division, Allgemeine Electricitats Gesellschaft, Berlin, Germany, recently returned to Germany after a six-week tour of various diesel engine manufacturing plants in this country. While here he presented a paper entitled "Some Recent Developments in Double-Acting Diesel Engines," before the oil and gas power division of the American Society of Mechanical Engineers.

Obituaries

ADOLPH LOMB, vice president of Bausch & Lomb Optical Co., Rochester, N. Y., recently died of pneumonia at his home in Pittsford, N. Y. He was 66 years of age. For 53 years he had been connected with the company of which his father was co-founder. In 1892 he graduated from the University of Rochester, later taking postgraduate work at Massachusetts Institute of Technology and at the University of Berlin, Germany.

* * *

Maurice Dornier, co-designer with his brother Claude, of the giant flying boat DO-X, died recently at Munich, Germany. He was 44 years old. Death resulted from an operation for a stomach malady contracted while he was serving in German East Africa during the World war. In 1924 Maurice joined his brother in the Dornier Works and was one of the passengers who made the transatlantic flight in the DO-X in 1931.

* * *

Dr. Frank Leroy Slocum, 76, consulting engineer, chemist and metallurgist in several Pittsburgh companies for nearly 50 years, died in Pittsburgh recently. He was born in Lima, Wis. His business associations at various times included Park Bros. & Co., Pittsburgh, later absorbed by the Crucible Steel Co. of America; Mackintosh-Hemphill Co., Pittsburgh, Carnegie Steel Co., Pittsburgh, and Firth-Sterling Steel Co., McKeesport, Pa. Besides holding patents on several mechanical and chemical developments, he was the author of numerous technical works.

TOPICS OF THE MONTH

(*Concluded from Page* 47)

based to definitions for practical applications. Nearly 200 individuals, in addition to the 120 serving on the committee and subcommittees, participated actively in the work.

* * *

W. B. Stout Sees New Engineering Era

ENGINEERING will offer unprecedented opportunities when the world emerges from its business lethargy . . . more new things will be demanded than ever before. Thus spoke William B. Stout, pioneer airplane designer, at a meeting of the Society of Automotive Engineers recently.

After discussing cars he commented on the railroad industry: "The trouble with the railroads is that they are mechanically sick, that is, their machinery has run down. They are running 130,000-pound cars to carry six passengers, whereas 13,000-pound cars would do the job better and at less cost. Rolling stock was designed in the days when we had only cast iron, wrought iron, steel and tool steel, and the railroad man's ideas of engineering have not changed to keep pace with the development of alloys and scientific heat treatment of steel."

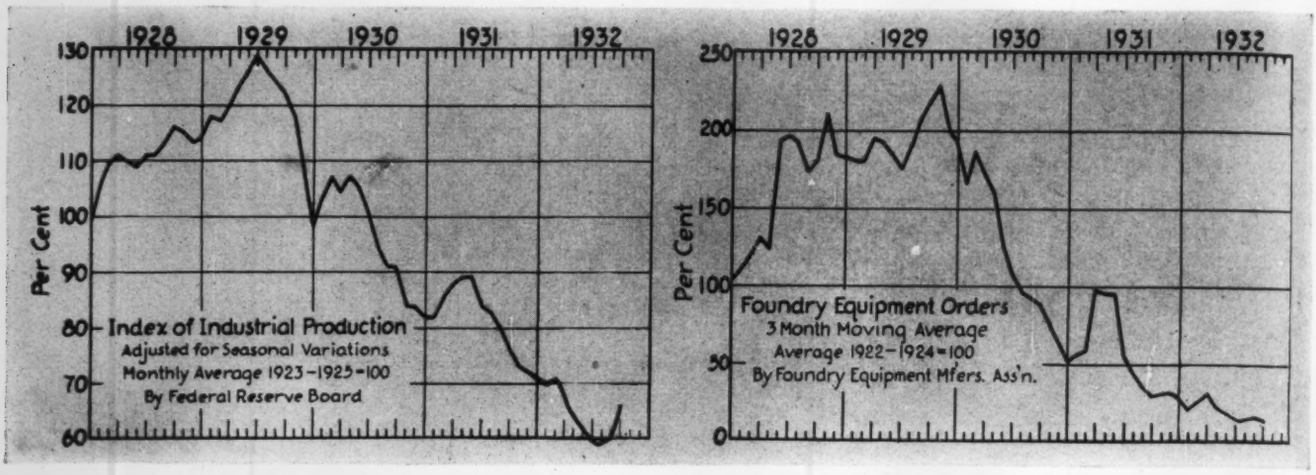
Considered to be the most outspoken critic of the automobile, Mr. Stout soon will have an opportunity to test his theories. Word comes from Detroit that he is organizing a company to back him in his experiments. The designer denies that he is concerned with manufacture, at least for the present. It is said it will take a year before his ideas are tested thoroughly.

* * *

Rehabilitation Group Holds Meeting

AT THE call of Frederick A. Geier, president of the Cincinnati Milling Machine Co., a meeting was held last month to lay plans for sending representatives into all types of industrial and business houses to show advantages of modernizing plants now. This marked Mr. Geier's first step as chairman of the committee on industrial rehabilitation for the Cincinnati area.

Figures were cited to show that since 1929 expenditures for equipment, machinery and plant facilities have declined from an annual outlay of $5,000,000,000 to a yearly expenditure of $1,260,000,000. This means, Mr. Geier said, that more than 50 per cent of the equipment of American factories is obsolete. Replacement has not kept pace with engineering advancement.

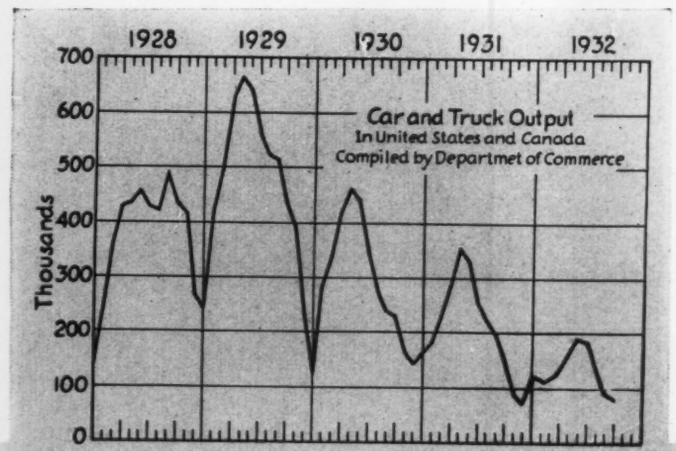


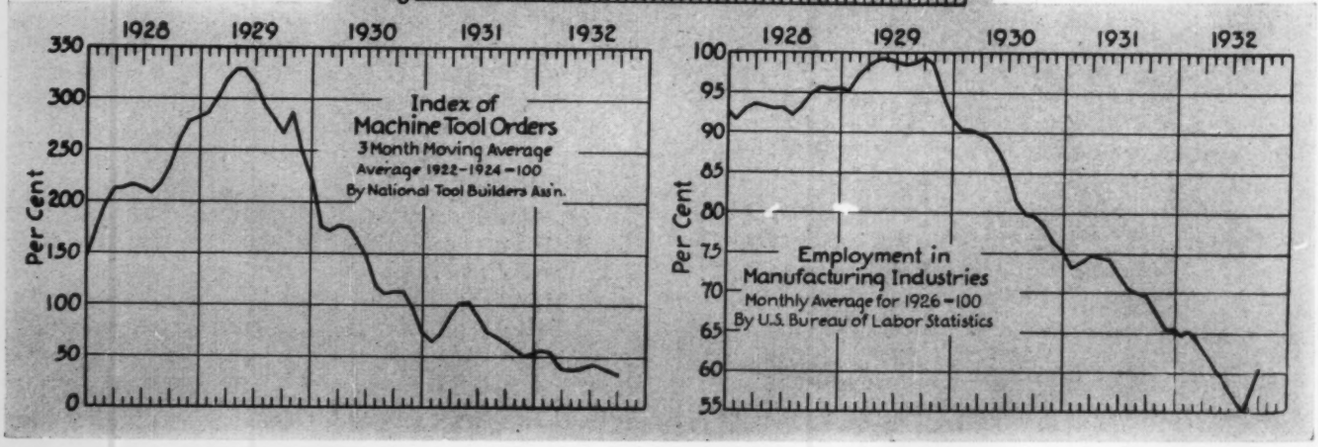
How Is Business?

IT HAS been a great many years since a presidential election had such an adverse effect on business sentiment as the one just concluded. A large number of actual orders were to be held until after the results were known, and business relapsed to a state of watchful waiting. There were many dire prophecies made by both parties, and now the truth of these prophecies will be tested.

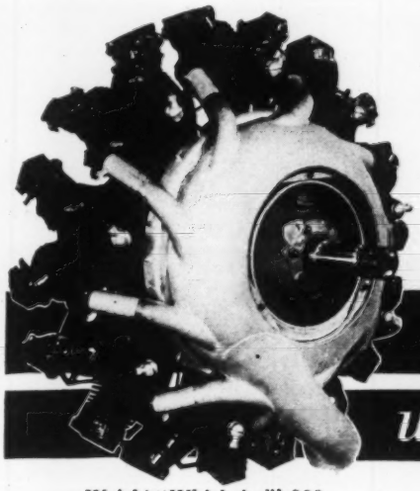
Despite this braking tendency of the political controversy, indications of recovery continued, evidencing considerable more life than did business sentiment. Greater than seasonal gains were registered in many indexes, while practically all were able to conform to the seasonal trend. Most encouraging were freight car loadings which continued to rise for three weeks longer than normal, steel operations which touched 20 per cent for the first time since June and electric power output.

Foreign trade showed the best favorable balance registered this year, while employment in manufacturing industries bounced upward 4.5 per cent, payroll totals increasing 5 per cent. The growing tendency to spread work should aid the employment index considerably, while the mere fact that there is some work to be had should bolster retail sales, the basic improvement needed for all industry. That the gains already made have aided in this field is evidenced by department store sales which doubled their usual seasonal gain. Other fields have shown equally encouraging expansion and expect further improvements.



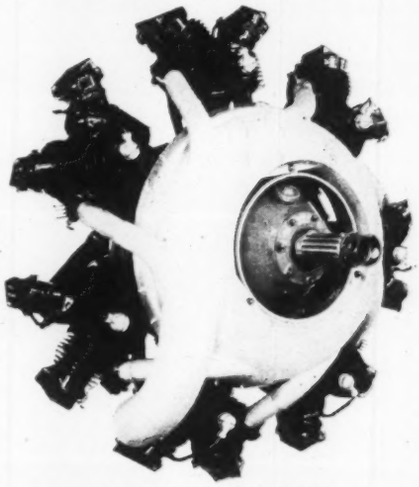


Eliminating Risk *from* Air Travel



Wright "Whirlwind" Engines *use* MRC-SRB BALL BEARINGS

Wright "Whirlwind" 300



Wright "Whirlwind" 240

Wright "Whirlwind" 165

MRC-SRB Ball Bearings have been used on Wright Engines for the last ten years. To any engineer this should be convincing evidence of their dependability. Bear in mind, too, that Wright is not alone in its high regard for MRC-SRB Ball Bearings . . . practically all American Aircraft Engine Builders use them.

When Ball Bearings are required for exacting performance, specify MRC-SRB—they have the endorsement of an industry that demands DEPENDABILITY.

Marlin-Rockwell Corp.

MANUFACTURERS OF

GURNEY SRB STROM M·R·C BALL BEARINGS

EXECUTIVE OFFICES . . . . . JAMESTOWN, N. Y.

FACTORIES AND OFFICES AT JAMESTOWN N. Y., PLAINVILLE, CONN., CHICAGO, ILL.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

NOISE and vibration, constant enemies of the designer, yield to a remarkable degree when rubber and similar nonmetallic materials are employed. A recent patent, No. 1,881,800, covers the construction of a propeller shaft bearing which typifies one method of attacking the problem of eliminating these factors. The invention relates to the mounting of power units and associated parts for marine use, and was conceived by Alfred F. Masury for the Rubber Shock Insulator Corp., Wilmington, Del.

Because the hull and superstructure of boats form an effective sound and vibration transmitting means, the elimination of these objectional features has long been an important object in boat designing. In Fig. 1 is shown the mounting of a propeller shaft within a hull by means of a bearing secured to the hull through nonmetallic cushioning elements whereby vibration and irregularities in the transmission of power will be isolated from the hull.

Propeller shaft a, mounted on rib a^1 of the vessel, is carried on the rib by bearing casting b which has a housing b^1. Arms b^2 are formed with seats b^3 and b^4. Locknut a^4 holds the ball race in position on the shaft. Bearing housing b^1 carries a second ball race which co-operates the race mentioned in the foregoing, and is held in position by a second locknut b^7.

Ends of arms b^2 are secured in the nonmetallic elements c. A housing d is fastened to rib a^1 and caps d^1 are adapted to confine the blocks c under compression. The degree of compression under which blocks c are carried may be varied by means of bolts at either side of caps d^1. The entire housing is shown, Fig. 1, as secured to rib a^1 by means of bolts d^3. Blocks c are formed with recesses which are designed to receive the ends of arms b^2 carrying seats b^3 and b^4.

Although the mounting for the bearing of the propeller shaft is of a yielding character, cushioning the vibration, the mounting is sufficiently positive to prevent an excessive movement of the shaft under the stresses which create the vibrations. This is obtained by maintaining the cushioning members under considerable pressure. Under such conditions vibration is deadened effectively without permitting appreciable movement of the shaft with respect to the mounting.

TO PREVENT motor overload with consequent circuit blow out, a safety device in the form of a throw-off has been designed to disengage a driven member from its connection with a driver. The mechanism is intended particularly for use in connection with bake ovens. Albert H. Rancke is the inventor with Petersen Oven Co., Chicago, assignee. Number of the patent is 1,879,486.

Designed to be interposed between the motor or power shaft and the gear reduction unit, the throw-off mechanism is constructed so that when an overload occurs it will disconnect the driving and driven elements automatically. Components of the device consist of a plate 16 mounted on the reduced portion of the bushing 12, being free to rotate upon the bushing. The face of the plate next the collar 13 is provided with a number of shoulders. Pulley 17 for connecting the structure with the gear reduction apparatus is bolted on one of these step portions, Fig. 2.

The opposite face of the plate 16 is designed with lateral lugs 18 arranged concentrically

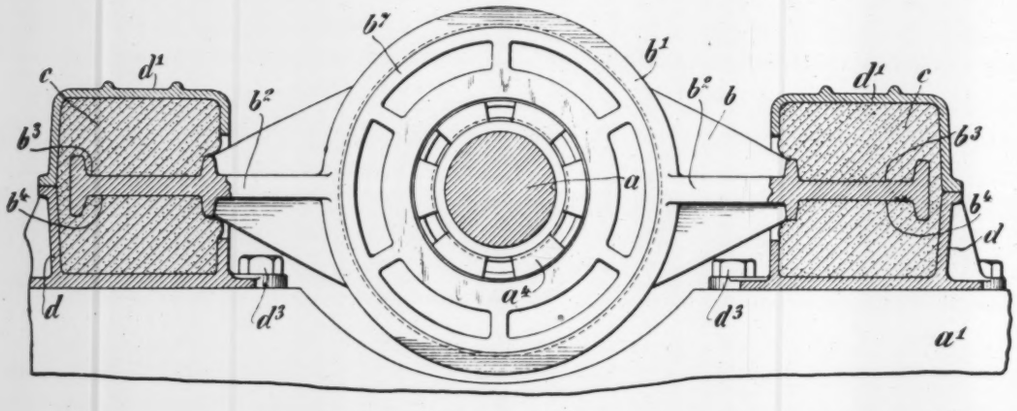
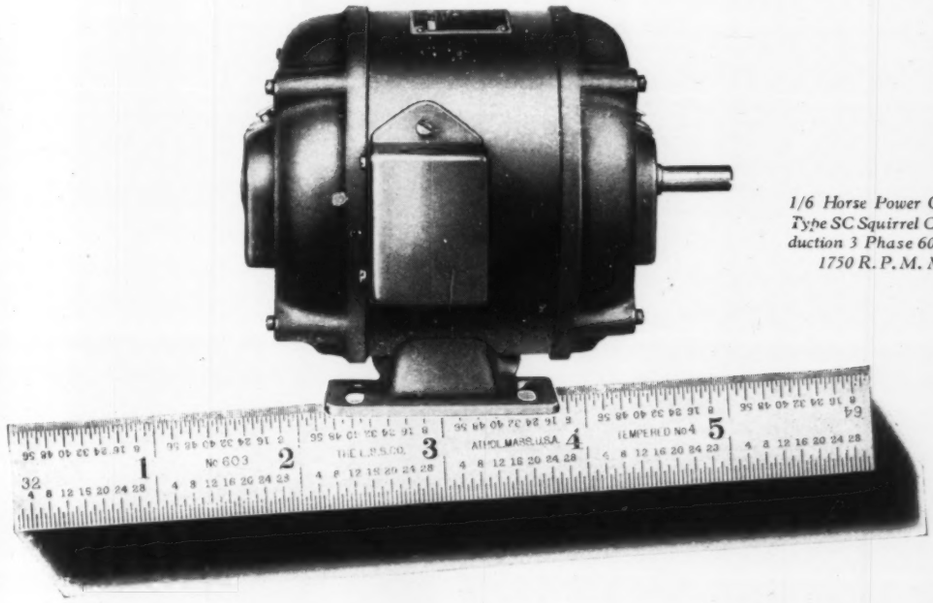


Fig. 1 — Nonmetallic cushioning elements under compression are utilized as a mounting for a propeller shaft bearing to form an effective means for reducing vibration and noise

"THEY KEEP A-RUNNING"



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around the central opening in the plate. Each lug has a wedge or cam-shaped face 19 that inclines upwardly away from the adjacent surface of the plate to provide the members that cooperate with other members to form the clutch. Depressions or sockets 20 in the tops of the lugs engage the rounded ends of studs 22.

Plate 21 has a bore slightly greater than the diameter of head 12 of the bushing and is positioned adjacent the radial projections 15. The face of plate 21 nearest the radial projections 15 is provided with lateral projections 24, the sides of which are engaged normally with projections 15 on the head of the bushing. When the shaft is rotated the interengagement of these projections 15 and 24 causes plate 21 to rotate and thereby revolve pulley 17 mounted upon plate 16 toward which plate 21 is urged by coil springs 29.

When a drag or stoppage occurs in the mechanism actuated by this apparatus the tendency of the pulley and disk 16 will be to stop, while the motor shaft 10 and its bushing will continue rotation, thus causing projections 15 to press tighter against pins 24. This causes studs 22 to ride out of sockets 20 and move down the inclined faces 19, due to the springs urging plate 21 toward plate 16. Projections 24 thereby are moved out of the path of pins 15, permitting the shaft and its head to continue rotation.

Movement is effected that will cause the pins 24 to move farther along in engagement with

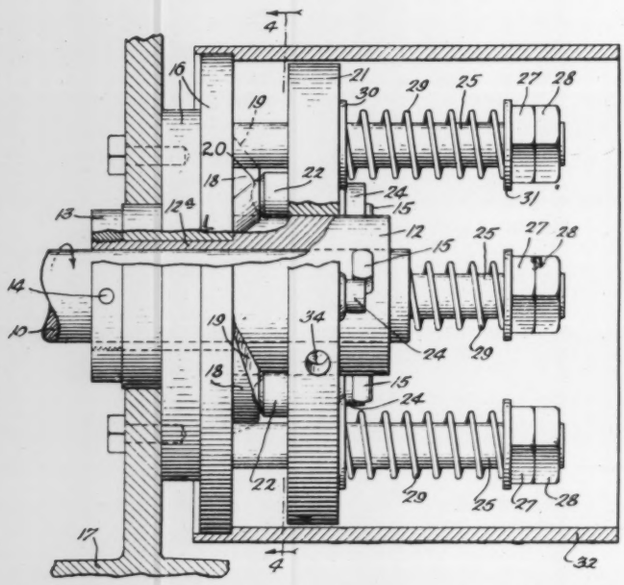

Fig. 2—Throw-off mechanism which is employed to disconnect driving and driven elements when overload occurs

radial projections 15 on the head or end of the drive shaft, and when the studs ride down from the highest edges of inclined faces 19 there will be a further or reverse movement of pins 24 against pins 15, until such time as the ends of one set of pins move out of the path of the other set. This under certain conditions might create too much friction or might too long delay the disengagement of the respective sets of pins. In order to hasten disengagement and reduce friction a modification of the structure was included in the patent.

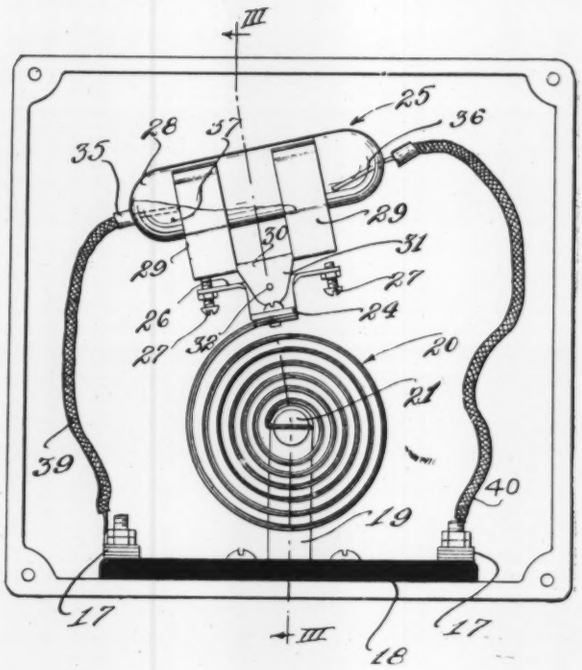

Fig. 3—Thermostatic material and mercury switch combined to be operated by temperature changes

COMBINING a mercury switch and a coil of thermostatic material, Charles L. Rayfield has devised a thermostatically controlled switch which is simple and inexpensive to manufacture. A patent covering the unit recently was issued, having been designated No. 1,881,-950 with the Rayfield Mfg. Co., Chicago, as assignee.

Properties of thermostatic metal in the form of bimetal was discussed at length by Howard D. Matthews in the August, 1932, issue of MACHINE DESIGN. Therefore the reaction of this type of material to changes in temperature will not be described here. It might be reiterated however, that where a rotating motion is desired the material is used in coil form.

Returning to the patent, it is interesting to note that Mr. Rayfield utilizes the thermostat itself as a mounting for the switch, Fig. 3. The coil of thermostatic material 20 is supported by bracket 19. Inner end of the coil 20 extends into and has a tight fit in a slot formed in one end of stud 21. The outer end of this coil has anchored to it a bracket 24 which carries a mercury switch 25 of conventional construction.

Adjustable studs 27 serve not only to limit the tilting movement or travel of switch 25, but also act as a means for determining the amount of movement of the coil necessary before the switch is tilted to either of its two positions.

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It certainly is gratifying when a purchaser of equipment writes in with a bouquet of violets regarding how well it does its work.

But the Brickbats! What a kick in the pants it is when the users write in and raise particular hell because the so-and-so equipment hasn't stood up.

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NEW MATERIALS AND PARTS

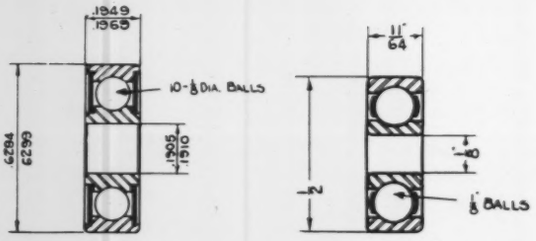
Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Small Sealed Bearings Are Announced

THREE new ball bearings of small size have been developed by Fafnir Bearing Co., New Britain, Conn. The double seal type, shown at the left in the illustration is the smallest offered in this design by the company. It comes prepacked with lubricant, and has the full ball complement for maximum static capacity. This bearing is made also in an intermediate small size, slightly larger in dimensions and capacity.

The miniature design, shown at the right, is said to be the smallest, lightest ball bearing ever made. It is especially adaptable to instruments and other light, delicate bearing applications.

Both completely assembled units are precision ball bearings in every respect. They are small



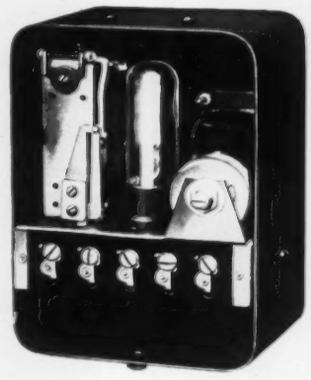
Precision ball bearings in unusually small sizes may be obtained with seals which protect against dirt and grit and retain lubricant

enough to be adaptable to many applications not hitherto possible. Seal types completely protected against dirt and grit retain the lubricant for long periods.

Relay Operates on Quick Changes

OPERATING on light impulses of one-fifteenth of a second duration the new photoelectric relay designed by General Electric Co., Schenectady, N. Y., is applicable to installations where practically complete interception of the light beam is made, since changes of light intensity of at least 50 per cent are necessary for successful operation. The relay, shown herewith, consists of a phototube, a Pliotron amplifying tube, a sensitive relay, an adjustable potentiometer and associated apparatus, all mounted on a steel base.

A cover with one opening for the phototube



Changes of light intensity of 50 per cent or over will operate small sized relay

and another for the potentiometer adjustment is proved. This cover may be replaced by one with an optical system should the application require it. Where the interrupting capacity of the sensitive relay contact is not sufficient to handle the device to be controlled, a small contactor or magnetic switch may be interposed between the sensitive relay and the controlled device.

Pump Parts Can Be Included in Design

STANDARD rotary pump parts, including a cover, idler pin, idler and rotor are being offered by Tuthill Pump Co., 131 West Sixty-third street, Chicago, for incorporation in the design of machinery. Complete dimensions are furnished by the pump manufacturer to insure proper machining. All diameters of the boring are concentric in the parts to facilitate machining. The only requirement is that the ports must communicate with the cored recesses in the parts

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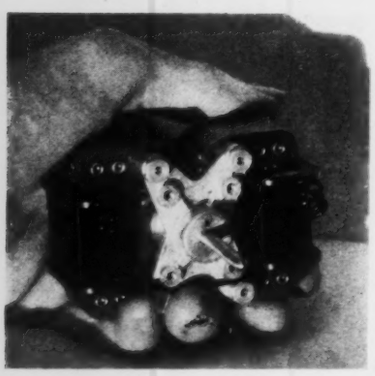
and be large enough to keep the velocity of the pumpage down to a figure consistent with its viscosity.

Port passages may be drilled or cored in any number of arrangements which the designer may choose. Under this system, the builder of the equipment is permitted almost any combination of port arrangement with assurance of a compact pumping unit. The intake and discharge ports will interchange when the direction of shaft rotation is reversed.

Shaded Pole Motors Have Slower Speed

SHADED pole motors which run at a slower speed than previous models with no sacrifice of starting torque or efficiency have been announced by Barber-Colman Co., Rockford, Ill. These motors, shown herewith, are of the core type of the same general design as other models except that they have four poles and therefore run at approximately half the speed. With this construction the "synchronous" speed is 1800 revolutions per minute. At full load the motor delivers 0.0035 horsepower at 1300 R. P. M. with an input of 23 watts at 115 volts, 60 cycles. Starting torque is 0.2 of a pound inch. Current drawn by the motor when stalled is but little more than when running at full load.

Two field coils are used, wound on phenolic resin spools and connected in series. There are two shading rings on each of the four poles. The hardened and ground shaft, 0.1845-inch diameter, runs in oilless bearings. This type of motor is suitable for driving a variety of mechanisms such as pumps, fans, advertising devices and similar equipment.



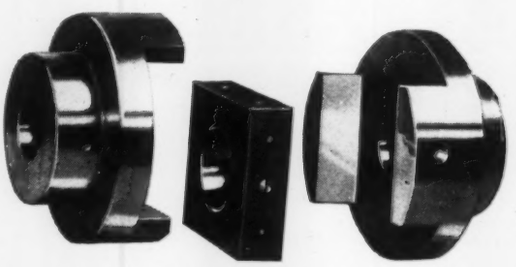
Slower speeds in extremely small motors are possible with new four-pole type

Nut Lock Suitable for Any Size Nut

AN AUTOMATIC nut lock which locks any style nut now is being marketed by Ohio Equipment Co. Inc., 5716 Euclid Ave., Cleveland. The lock unlocks by giving the nut a quarter turn backward with an ordinary wrench. Locking action is obtained by flat spring wire placed in a slot which extends the complete depth of the nut at one corner and is bent over to meet the bolt threads. The wire closely fitting in the slot causes the free end of the lock to make a pressure contact on the bolt threads when the nut is run on. This contact resists backing off and vibrational forces. When the nut is to be released, a quarter turn pushes the lock away from the nut and reverses the slant with relation to the center line of the bolt, allowing the nut to be turned off easily. The fastening is made in sizes ½-inch and larger and the company can apply the lock to nuts furnished by manufacturers.

Coupling Employs Only Three Parts

PROVIDING complete flexibility with only three parts, the new coupling designed by D. O. James Mfg. Co., 1114 West Monroe street, Chicago, has a center member made of non-metallic material self-lubricated by means of a reservoir within itself. The floating center member of the unit, shown herewith, slides between the jaws of one metal flange on a line passing through the center. It is free to slide across the face of the second flange in a direction which is at right angles to the first, making it mechanically flexible without the use of flexible materials. The two metal flanges are made of nickel iron of high tensile strength.



Non-metallic material used as center piece in new coupling is lubricated by means of a reservoir within itself

Stress Is Equalized in New Belting

EQUALIZATION of the stresses developed in the plies is accomplished in the new compensated belting brought out by Manhattan Rubber Mfg. division of Raybestos-Manhattan Inc., Passaic, N. J., by a special method of manufacture designed to balance the stress when the belt is flexing around large or small pulleys. It is

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Attention of Mr. J. R. Maddock - Sales Agent

SUBJECT: General Electric Gear-Motors

It has occurred to us that you might be interested in the reactions of our customers to your new gear-motors and so we are pleased to give you the following report as to their advantages:

1. You can give us practically any speed we require for driving Kinney Pumps even where accurate quantities are required.
2. The complete unit of pump and motor is very compact.
3. The entire unit is practically noiseless.
4. The pump is readily accessible for inspection and repairs.
5. No thrust is transmitted from the motor to our pump shaft.
6. This type of gearing with its quiet operation is acceptable to many of our customers who formerly objected to the noise of the gear and pinion drive.
7. As compared with building a reduction gear in the head of our pump,this unit has the further advantage that the gears can be lubricated with the proper grade of oil instead of being lubricated by the material being pumped, or,if the gear case were filled with oil,running into the danger of contamination from the material being pumped.

The photographs illustrating our gear driven unit and the new unit using your motor direct connected through flexible coupling speak for themselves.

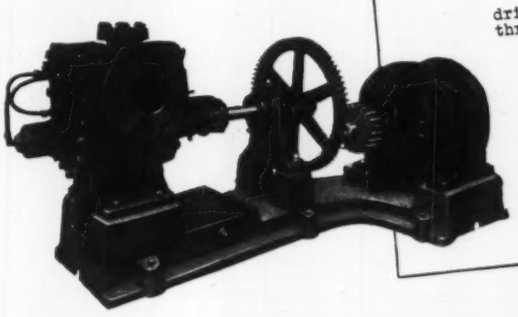
Very truly yours

KINNEY MANUFACTURING COMPANY

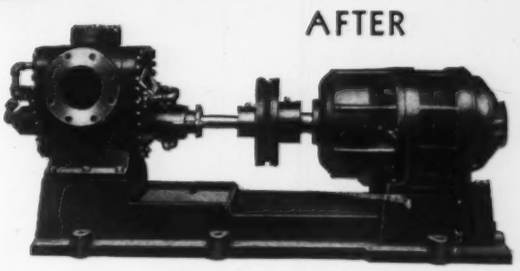
William E. Worcester

William E. Worcester
Vice President in Charge of Sales

BEFORE



AFTER



The G-E gear-motor delivers full-rated horsepower at the output shaft at the low speed you desire. The simplicity, compactness, and efficiency of this unit are available not only for pumps but also for conveyors, compressors, machine tools, and many other industrial applications.

Information on the complete line of gear-motors can be obtained from the nearest G-E sales office or G-E Motor Dealer, or from General Electric Company, Schenectady, N. Y.

200-659

GENERAL ELECTRIC

claimed that no trouble will be experienced from ruptured outside plies. Balancing the tension also reduces the tendency for fasteners to work loose and pull out. A specially treated pulley surface increases the coefficient of friction. The belts, which may be made endless, are furnished with from 2 to 8 piles in widths of from 1 to 48 inches.

Develops Stoker Drive Units

DRIVE units for driving both fan and screw of underfeed domestic and industrial stokers are a recent development of Foote Bros. Gear & Machine Co., 5301 South Western boulevard, Chicago. The design of this industrial drive consists of a hardened and ground worm integral with the shaft which drives a bronze worm gear. This gear has a bronze eccentric cast integral and the eccentric drives a hardened steel driving yoke which reciprocates on the eccentric and drives the pawls which engage a hardened cut tooth ratchet wheel keyed to the slow speed shaft by the shear keys. The ratchet wheel is bronze bushed and the hub is extended and runs in a bronze bushing.

Designs Vertical Motorized Reducers

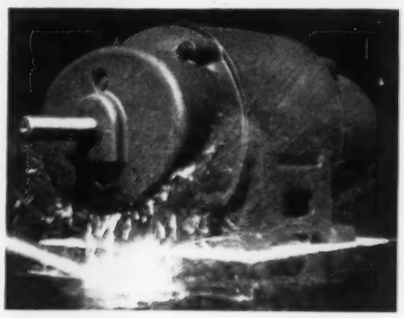
VERTICAL units in the line of MotoReduceR equipment announced by Philadelphia Gear Works, Philadelphia, in the October issue, have been developed by the company. These reducers, shown herewith, have the same operating equipment as the horizontal units. They are available in single, double and triple types with ratios up to 450:1 and can be furnished with standard open type or totally enclosed fan cooled motors, polyphase or single phase. Direct current motors up to ten horsepower may be incorporated in the unit.

All gears in vertical motorized reducer are made from heat treated nickel steel, have helical teeth and are run in an oil bath. Bearings are of the antifriction type

All gears are made from heat treated nickel steel with helical cut teeth and all bearings are of the antifriction type. The slow speed shaft is mounted on roller bearings which compensate for upward or downward thrust and take care of the side whip of the extended vertical shaft. This construction eliminates the use of the step bearings.

Splashing Liquid Is Kept from Motor

PROTECTION against water splashed under pressure from any angle is afforded by the new motor built in the same dimensions as standard open motors by Louis Allis Co., Milwaukee. A double baffle in an elliptically shaped air passage in each end-bell provides the protection offered by this motor, shown herewith. The construction permits free passage of air, yet it traps and drains water splashed into the air openings at the bottom of the chambers. Another feature is a shaft guard which breaks the force of a stream directed along the shaft extension and prevents water from entering the bearing chamber. The new motor eliminates the necessity for sheet metal covers which might restrict ventilation. It is suitable for applications in dairies, meat packing plants, canneries, breweries, paper mills, boiler rooms and locations of a similar type.



A double baffle in an elliptically shaped air passage provides protection for enclosed motors

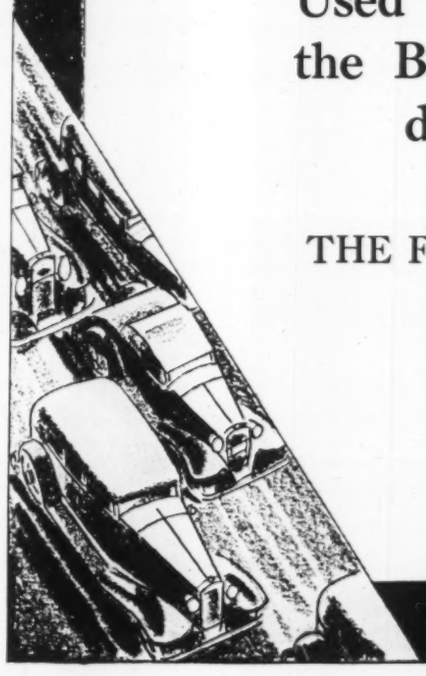
We are approaching the time when we will no more tolerate a clash in color values or inartistic elements of design than we would permit clashes of mechanical parts of our apparatus, according to Donald R. Rohner director of the art-engineering department of Westinghouse Electric & Mfg. Co.

FEDERAL BEARINGS

FEDERAL BEARINGS are preferred by manufacturers in various industries where dependable bearings are essential to long and efficient service.

EVERY PROCESS, during the manufacture of FEDERAL BEARINGS, is carefully checked. The steels used, are scientifically heat-treated and thru-hardened. Constant inspections permit only perfect bearings to leave the Federal plant.

Federal Bearings are Bought and Used With the Knowledge That the Ball Bearing Industry Produces Nothing Better



THE FEDERAL BEARINGS CO., INC.
Poughkeepsie, N.Y.

Detroit Sales Office: 2608 Book Tower
Chicago Office: 120 Peoria St.

ALLEN

TRI-MARK

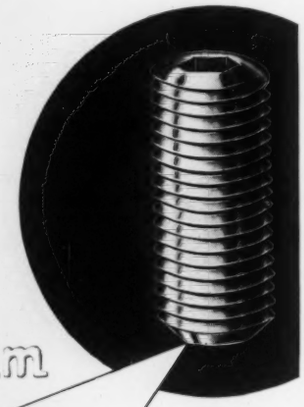
TRADE MARK

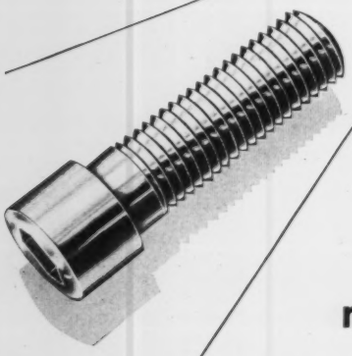
HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um





ALLEN has not joined the mad scramble to manufacture to a price

Panicky price-cuts on Hollow Screws are evidence to you of "cut" operations, reduced care in testing, relaxed inspection. Allen neither adopts the price-cuts nor the cheapening process which permits them. We supply our customers a constantly better screw, but not at a "better" price than Quality will allow. You still get the costliest screw to make but the *CHEAPEST SCREW TO USE* in production machinery.

THE ALLEN MFG. COMPANY

HARTFORD, CONN. U.S.A.

Reducing Bearing Friction by Special Design

(*Concluded from Page* 30)

number of balls of somewhat smaller size. Dividing the load among more balls reduced the load per ball and the size of the contact area. This effect, combined with the flatter curvatures, was estimated to reduce the friction to one-half or less. Whether the dynamometer sensitivity would be improved sufficiently could not be determined without actually building the bearing and installing it.

Friction of Bearing Decreased

After installing the new bearing a measurement of the zero reading showed 3 pounds total at 21 inches or 1.5 pounds each way. The friction was halved, making the coefficient approximately 0.0008. It also was noticed that the friction increased somewhat erratically after a fraction of a turn, but this effect had no direct bearing on the immediate problem. The dynamometer sensitivity was still too coarse. A considerable improvement had to be found.

After careful consideration of the factors involved, the special arrangement shown in Fig. 2 was designed. The pivot bearing itself was to be mounted on an auxiliary base and rotated continuously in one direction at a slow, steady speed. Bearing friction then would produce a constant, steady drag in one direction, and it could be subtracted as a zero setting or subtracted from each reading.

This arrangement was installed readily in the same space by employing two bearings of the same size opposed to each other, with a floating ring between the inner races. The ring rotates by means of gear teeth cut on the outside, a small countershaft and a worm drive all mounted in a new base casting. The worm is coupled to a fractional horsepower motor at one side. Fig. 1 shows the arrangement.

Sensitivity Is Improved

The new mounting improved the sensitivity of the dynamometer more than was expected and fulfilled the needs of this application. The only error remaining was that due to small variations in the bearing friction itself. Sensitivity of the dynamometer no longer could be measured directly as a zero reading, but was calculated from the curves which now were smooth and sharp. The maximum error is estimated at less than 1/10-pound at 21 inches—about 1/60 of its original value. This error only amounts to 1/50 per cent of the maximum scale reading of 500 pounds, and this sensitivity has not changed noticeably in more than a year.

Quality
IN THE PRICE CLASS

The demand today is not for price or quality alone *but for quality at a price* ... The model E E and E E X motors illustrated meet this exacting requirement .... These motors are built to the well-known Dumore quality standards. They develop 1/75th H. P. and are of the universal type with balanced armatures. They are enclosed in a tightly-fitting die cast housing and are equipped with self aligning bearings in addition to possessing other typical Dumore quality features . . . Investigate the application possibilities of these two models! .... Send us a print of your requirements. The Dumore engineering staff may be of assistance to you in the application of either of these two Dumore models to your product.

DUMORE COMPANY
100 16th Street Racine, Wis.

Send for bulletins which fully describe the Dumore Double Gear Reduction Units. These bulletins contain complete technical data regarding reductions, shaft speeds, dimensions and etc.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

DIVINE DISCONTENT

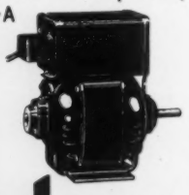
The propelling force in man . . . that urge to improve what he has already done well . . . is, in the words of Plato, a "divine discontent."
The unceasing efforts of Leland engineers to make the Leland motor better and better . . . and still better . . . aptly illustrates what that eminent philosopher had in mind.

To illustrate: It is common knowledge that motors for oil burners, stokers, air conditioners and refrigerators must be QUIET. Consequently, all inherent noises and sources of noise must be isolated within the motor itself. Transmitted vibration must be eliminated. How well that has been accomplished in the Leland cradle base design is well known. That which is not so well known is the fact that Leland engineers finished the job—went farther—designed a mounting that would "stay put" regardless of weight, belt pull, load thrust and other tendencies to dislocate the motor shaft with respect to the motor base and the driven load.
Can you rest content with any motor other than the best for your requirement?

A. C. Repulsion-Induction Polyphase Capacitor motors
D. C. and Specials where required

The Leland Electric Company
Dayton · Ohio · U·S·A

CANADIAN ADDRESS TORONTO
CABLE ADDRESS LELECT



Leland Motors

Business and Sales Briefs

ELECTRIC Motor Corp., recently was organized at Racine, Wis., for the purpose of manufacturing fractional horsepower universal motors. Officers of the company are I. H. Dunham, president; R. H. Kellogg, vice president; and H. S. Wagoner, secretary and treasurer. Principal offices and factory are located at 401 Lake avenue, Racine, Wis.

* * *

I. L. Jennings is now director of sales of Lamson & Sessions Co., Cleveland, bolt and nut manufacturer, succeeding C. H. Longfield who resigned recently.

* * *

Plykrome Corp. has moved its offices from the Transportation building to 1 Wall street, New York, room 1702.

* * *

William Giles Newton has opened an office as consulting engineer specializing in die castings and die casting equipment at 151 Court street, New Haven, Conn.

* * *

Cole Automatic Nut-Lock Corp., Elwood, Ind., has appointed Ohio Equipment Co., 5716 Euclid avenue, Cleveland, as sole distributors of its lock nuts.

* * *

Machinery & Welder Corp., formerly at 2604 North Cicero avenue, Chicago, moved recently to new and larger quarters at 316 North Sheldon street, Chicago.

* * *

J. Edward Daily, formerly a vice president of the Timken Roller Bearing Co., Canton, Ohio, has been named general manager of the Steubenville works of the Wheeling Steel Corp.

* * *

Baldwin Locomotive Works, Philadelphia, and subsidiary companies are the most recent organizations to be licensed by Dardelet Threadlock Corp., New York, to manufacture bolts, nuts and other parts threaded with self-locking thread.

* * *

Fred C. Archer has been appointed as manager of the Philadelphia district by Lincoln Electric Co. with offices at 401 North Broad street, Philadelphia. This office maintains a sales and service organization for all products of the Lincoln company.

* * *

Barbour Stockwell Co., Cambridge, Mass., is now selling in the New England territory the complete line of silent and roller chains and sprockets manufactured by Whitney Mfg. Co., Hartford, Conn. Roller chain will be carried in stock at Cambridge, Mass.

* * *

Marlin-Rockwell Corp., Jamestown, N. Y., has consolidated the sales activities of its subsidiaries, Gurney Ball Bearing division, Jamestown, N. Y.; Standard Steel & Bearings Inc., Plainville, Conn.; Strom Bearings Co., Chicago. The bearings manufactured by all of the companies will be available through the executive and general offices at 402 Chandler street, Jamestown, N. Y., eastern district sales office at Plainville, Conn., and western district sales office at 2526 South Michigan boulevard, Chicago. Branch sales offices will be continued at their former addresses in Detroit, Cincinnati, Cleveland, Los Angeles and San Francisco. A new branch sales office has been opened at 40 West Sixty-third street, New York.

BALANCE

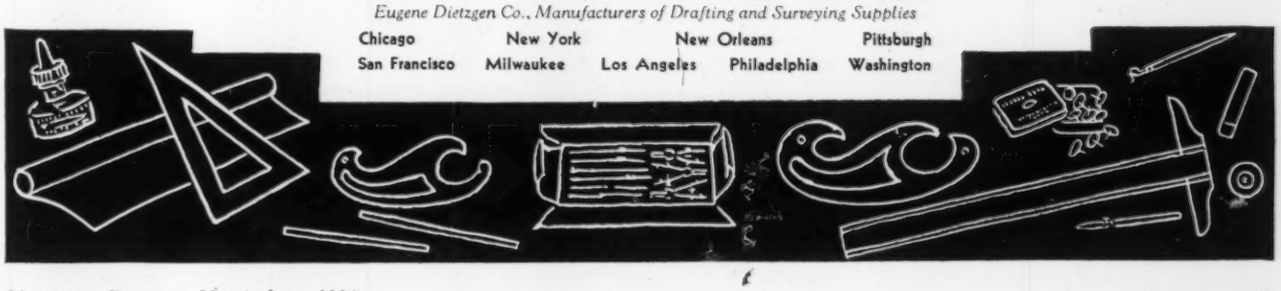
WATCH the expert draftsman . . . observe the skilled precision of his work . . . then notice the instruments he uses . . . DIETZGEN of course. Each one balanced accurately, carefully, with a thorough understanding of the importance of perfect weight distribution » » » Delicate balance is one of the differences between "drawing instruments" and DIETZGEN Instruments. Scientific perfection, absolute accuracy, sturdy construction, easy adjustability, and standard interchangeable parts are some of the reasons why DIETZGEN instruments are used where big things are done.

So for value and long satisfaction, use DIETZGEN Drawing Instruments.

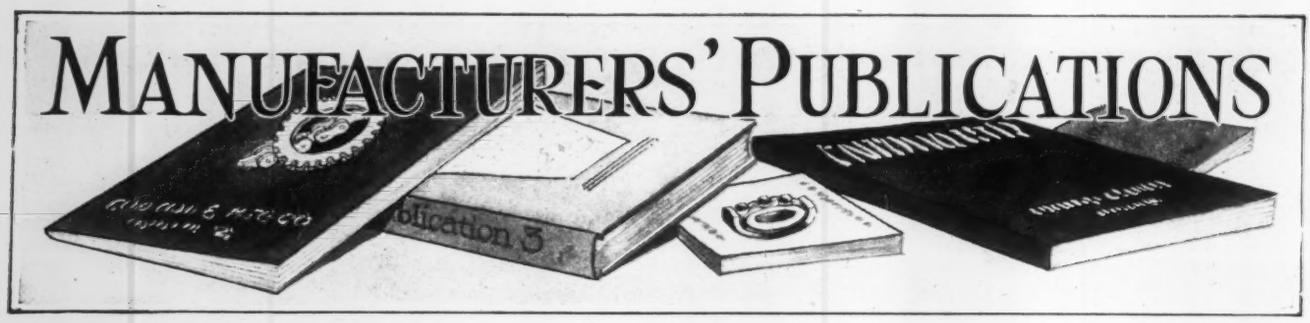
DIETZGEN

Eugene Dietzgen Co., Manufacturers of Drafting and Surveying Supplies

Chicago New York New Orleans Pittsburgh
San Francisco Milwaukee Los Angeles Philadelphia Washington



MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOY (STEEL)—Crucible Steel Co. of America, New York, has issued a bulletin on its line of stainless steels. Uses presented pictorially include equipment in the dairy, culinary and institutional fields.

BEARINGS—Engineering information on sheave mounting is included in application sheet No. 201 FE issued by New Departure Mfg. Co., Bristol, Conn. The sheet considers the problems presented and how they may be overcome. Mountings for mine car wheels are covered in No. 200 FE.

BEARINGS—Fafnir Bearing Co., new Britain, Conn., has published the sixth edition of its engineering data book. The book, brought up to date in all respects, embodies all dimension and design details of internationally standardized ball bearings as well as many special types. Applications are covered completely.

CAST PARTS—New Jersey Zinc Co., New York, has prepared an attractive engineering booklet on Horse Head Zinc for Die Castings. Charts and a table on the effect of aging treatments on tensile strength, impact strength and dimensions of the alloys are presented for the first time. Other topics discussed are heat treatment for stabilizing the dimensions and properties of the castings, machining, inserts and finishing. Excellent photographs show the types of die castings which may be secured.

CLUTCHES—Engineer's Specialty Co., Chicago, has prepared a booklet on the Columbia One-Way Clutch Coupling which is designed as a free wheeling unit for industrial equipment. Action is obtained by motion of eccentric cams which grip an enclosing case as it turns, and revolve the driven shaft. When the driven shaft rotates faster than the driving shaft the cams allow the case to slip past freely.

DRIVES—Constant tension drives for application to any process requiring a constant tension in material being wound upon or unwound from a reel are presented in bulletin 602 of Reliance Electric & Engineering Co., Cleveland. The bulletin describes the equipment and gives engineering information on the principle used.

DRIVES—Link Belt Co., Indianapolis, has prepared a 144-page catalog on steel chains in which information on the older chains is brought up to date and many new and useful sizes are offered for the first time. The sizes range from the small detachable chain having an ultimate strength of 950 pounds to powerful chains of as great strength as 1,500,000 pounds. The book is No. 1192.

DRIVES—Variable speed motor pulleys and countershaft units are presented in Catalog V-200, prepared especially for the information and reference of machine designers and manufacturers by Reeves Pulley Co., Columbus, Ind. The catalog gives complete engineering information on the units and applications and engineering tables. The principle employed in the drives is described and the formulas used are explained.

DRIVES—Dayton Rubber Mfg. Co., Dayton, O., is issuing a new industrial catalog on its cog-belt drives known as No. 105 Condensed. This publication, which includes all data pertinent to the selection of V-belt drives, has been made compact for ease of filing and inclusion in binders. Engineering information and formulas are given, as well as descriptions and photographs of installations.

FASTENINGS—Automatic lock nuts which do not require special tools for their operation are covered in a pamphlet distributed by Ohio Equipment Co. Inc., Cleveland.

GEARS—Engineering data on large hypoid and spiral bevel gears is included in Form No. 600 issued by Gleason Works, Rochester, N. Y. The 24-page booklet contains complete information on the design, application, efficiency, speeds and horsepower transmission of these two types of bevel gears besides standard specifications from which the engineer can select gears suitable for specification.

MOTORS—Midget motors which have maximum output of from 0.00035 to 0.0060 horsepower depending on the type are described in a series of data sheets published by Barber-Colman Co., Rockford, Ill. The sheets cover two-pole reversing, two-pole geared head, four-pole unidirectional and two-pole unidirectional types and general information on shaded pole motors.

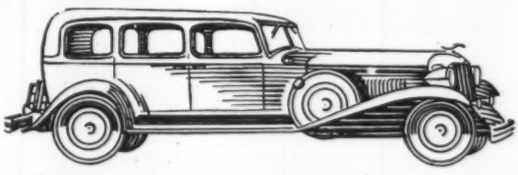
PACKING GLANDS AND PACKING—Garlock Packing Co., Palmyra, N. Y., is distributing Catalog B, a well-prepared 157-page book which covers packing manufactured by the company. This attractive and comprehensive publication includes information on the application and care of packings, selection and general recommendations in addition to photographs, descriptions and specifications of over one hundred types of metallic and composition packing for a large number of uses.

RUBBER—Hard rubber products for industrial purposes are presented in catalog No. 1 of the American Hard Rubber Co., New York. The publication includes physical, chemical and electrical properties of the material and describes molded and fabricated parts made from hard rubber.

STEEL PRODUCTS—Jones & Laughlin Steel Corp., Pittsburgh, is distributing a booklet on the products made

YOUR PRODUCT must be lighter?

Call upon Electromet Service



■ If your product must be made lighter without a sacrifice of strength, one solution is to replace ordinary steel with alloy steel parts. Before you write your specifications, however, supplement your knowledge of alloy steels with the vast fund of practical information that Electromet Service offers you without charge. As the pioneer producer of ferro-alloys and metals for steel-makers, Electromet has accumulated a body of data which, applied to your problems, will insure utmost economy in design and maximum satisfaction in performance. To realize maximum return on your investment in alloy steels, utilize Electromet Service. A request on your letterhead will bring you complete information.

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